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International Conference on Climate Change, Biodiversity and Food Security in the South Asian Region

ABSTRACTS

3rd & 4th NOVEMBER 2008

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Punjab State Council for Science & Technology,
Deptt. of Science, Technology & Environment, Govt. of Punjab
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ISBN No : 978-81-88362-24-0

Year of Publication : November, 2008

Citation
Singh, Gurharminder., Jerath, Neelima and Ladhar, S.S. 2008. Abstracts. International Conference on Climate Change, Biodiversity and Food Security in the South Asian Region. Punjab State Council for Science and Technology, Chandigarh and United Nations Educational, Scientific & Cultural Organization, New Delhi; P : 133

Citation of Paper
Gupta, N., Sharma, R.C., Mahal, G.S. & Jindal, N. 2008. Seed Storage for Food Security. In : International Conference on Climate Change, Biodiversity & Food Security in South Asian Region (Eds: Singh, G., Jerath, N., Ladhar, S.S.), November, 2008, Punjab State Council for Science & Technology, Chandigarh and United Nations Educational, Scientific & Cultural Organization, New Delhi. P : 64

Published by
Punjab State Council for Science & Technology,
MGSIPA Complex, Sector 26, Chandigarh - 160 019.
and
United Nations Educational, Scientific & Cultural Organization,
B-5/29 Safdarjung Enclave, New Delhi-110029

The digital copy of this publication is also available at www.punenvis.nic.in

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CONTENTS

POLICIES
&
PERSPECTIVES

HUMAN DIMENSIONS OF CLIMATE CHANGE

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The rapid global change initiated due to industrial revolution at the beginning of the 19th century has resulted in the extensive degradation of almost all ecosystems on earth. The primary anthropogenic causes of the global change are land cover and land use change, movement of biotic materials, and climate change. Human beings, by their activities such as land use change, fossil fuel driven economy, changes in the hydrological cycles (like excessive use of ground water), depletion of stratospheric ozone due to CFC pollution to name a few, have lead to changes in the global climate at rates which have been unprecedented during the history of earth. The challenge today for the Global Change modelers is to accurately predict the changes in the future land use and land cover in relation to climate change to enable us to undertake remedial actions before it is too late.

Climate change is a manifestation of the changes in the land use, land cover, vegetation fraction, heat flux which has a feedback loop with the regional climate. The influence of climate change on the Land use and land cover and vice versa has lead to inclusion of the complex parameter of anthropogenic factors in the physical models of the regional climate. Till date most of the climate models have taken into account only the geo-physical parameters to model the global and regional climate. The need of the hour is to first model the human dimension of climate change using a combination of space based and field data incorporating socio-economic, vegetation, hydrological, and ecological database in a geospatial domain. The human dimension of climate change involves estimation or modeling of the human footprint on the biosphere at regional level.

Climate models are one of the major tools to understand the climate change but since it is not possible to conduct the climate change experiments in a controlled environment so, the climate models are physical approximations appropriate for large scale climate systems.

Today most of the horizontal resolutions of the global models are within 100 to 300 km., therefore any climate change for land cover change smaller than that cannot be resolved. The major hurdle to the availability of finer resolution climate models is the unavailability of high resolution input at spatial and temporal scale for the model like land surface, vegetation fraction, LAI, albedo, total radiation, heat flux etc.

With the advent of satellite based observation platforms there has been a quantum shift in the availability of data on the temporal as well as spatial scales. The satellite based remote sensing gives temporal as well as spatial data on land use and land cover, vegetation fraction, albedo, land surface, at various resolutions which can be incorporated into the climate models for generating high resolution climate parameters. The main factor which is hindering the high resolution climate models at regional level in Indian subcontinent is the availability of other ground based data like precipitation, surface temperature, soil moisture, evapo-transpiration at sub-kilometer scale. This unavailability of ground based data can be offset by developing high resolution regional climate models for establishing bioclimatic envelop and predicting its change to enable us to model the land use and land cover change.

In light of this ISRO has initiated a program to study the human dimension of climate change of the 14 major river basins of the country to understand the influence of socio-economics, economic development, and energy consumption patterns in climate change using multi temporal satellite data of over four decades. As a part of the pilot study four river basin including, the Pennar river basin has been carried out. The initial results in the Pennar river basin showed that influence of urbanization in the river basin is driving the landuse practices. Furthermore as a result of increasing population pressure, there is a tendency towards intensive agriculture and effort to reclaim the wasteland areas. In the coastal regions of the Pennar river valley, aquaculture is replacing the traditional agriculture due to its higher financial returns.

ADDRESSING CLIMATE CHANGE & BIODIVERSITY ISSUES IN THE SOUTH ASIAN REGION

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Climate change issues are of global concern but pose major challenges for South Asia and require regional mitigation and adaptation responses. The region is home to a fifth of the world's population, and 40 percent of its poor. According to the FAO (Food & Agriculture Organization), about 312 million people, or nearly 21 percent of the region's 1.5 billion people, including half of its children, still do not get enough to eat. Climate change is already having major impact in the region with extreme weather events and sea level rise being observed with greater extent and frequency. These changes are already having major impacts on the economic performance of South Asian countries and on the lives and livelihoods of millions of poor people who are most at risk. Countries of the South Asian region with majority of the population is dependent on agriculture and natural resources for their survival and livelihood, face major threats due to increasing frequency and magnitude of extreme climatic events. The human dimension of this change is still not studied properly as climate change is likely to disrupt economic and social life of the people of the region in a significant manner. The impact will be much more acute in the impoverished regions and populations who may bear the brunt of these changes. This discrepancy is also evident in the ability to adapt and respond to climate change. Therefore, addressing climate change within the South Asian context will require new types of social institutions, cooperative responses and new forms of governance.

South Asia is representative of five of the fourteen major ecological regions called biomes, which demonstrate the biodiversity and vegetation patterns of the region as determined by climate, water, geology, soil and diverse topography. The region's topography consists of an amazing variety of mountains, plateaus, dry regions, intervening structural basins, beaches, etc. It varies from world's highest point, the Mount Everest to the world's lowest, the sea beach. The region is rich in biodiversity wealth and houses approximately 15.5 and 12 percent of the world's flora and fauna respectively. It contains a number of biodiversity hotspots of global importance, biosphere reserves and World Heritage natural sites that are home to some of the rarest and most endangered species in the world.

Among the most significant sites are the Terai grasslands and forests of the southern Himalayas; the Western Ghats biosphere of western India; and the Sundarbans wetlands of West Bengal and Bangladesh. Human pressures together with changing hydrology are having a discernible impact on the productivity and resilience of these ecosystems, and detailed studies are needed to evaluate the consequences of climate change on the life-sustaining ecological services they provide.

There have been very little studies on the impact of climate change on biodiversity in South Asia. The UNESCO report on Climate Change and World Heritage outlines the threats posed by climate change to natural and cultural sites on its World Heritage List. The report mentions that the melting of Himalayan glaciers are affecting the outstanding beauty and destroying the habitat of rare wildlife species such as the snow leopard, in the Sagarmatha National Park, Nepal. The report examines the effects of climate change on the marine World Heritage sites. Seventy percent of the world's deep sea corals are expected to be affected by changing conditions related to rising temperatures and increased oceans acidification by the year 2100. The report describes the threat to biodiversity which may lead to changes in the distribution of species, including "invasive species", pathogens and parasites and on the timing of biological events, such as flowering, and the relationships between predator and prey, parasite and host, plant and pollinator, etc. The report recommends several measures to deal with this problem, including the creation of protected areas and relocating particularly endangered species.

Besides loss to the biodiversity , the climate change will cause ecosystem boundaries to move, allowing some ecosystems to expand into new areas, while others diminish in size as the climate becomes inhospitable to the species they contain. It has been reported that if climate continues to warm it could dramatically increase the number of extinctions of species. Climate change may also induce changes in the genetic makeup of species. The warming temperatures may induce changes in the timing of reproduction in certain species; in the length of the growing season in many regions; in the abundance of different species; and in the frequency of pest and disease outbreaks. The melting glaciers in the Himalayas are a major concern for the hydrology and ecology of not only the mountain region but millions down below in the subcontinent. Agriculture represents a fourth of India's national income, and that sector could be seriously disrupted by changes in the monsoon pattern with increasing

droughts and floods. Appropriate adaptation and mitigation strategies are needed to deal with the risks particularly water management and crop resilience based on agro-biodiversity. The impact of climate change on the biodiversity of marine, coastal and island areas will have very devastating consequences. The small island nations like Maldives are already facing huge problem in terms of loss of corals and other marine biota including fisheries. Bangladesh, is most vulnerable to natural hazards like cyclones, floods and salinization of coastal areas. Bangladesh may lose as much as one-third of its land mass due to sea level rise. Those coastal ecosystems which are particularly at risk include saltwater marshes, mangrove ecosystems, coastal wetlands, sandy beaches, coral reefs, coral atolls, and river deltas. The increased water temperatures have adversely impacted the corals and other organisms living in coral reefs. Species restricted to small areas, or in small populations, are also particularly vulnerable. A catastrophic event such as disease or drought, for example, can kill off a small population. And populations in small, isolated habitats are unlikely to be replenished once decimated by outbreaks of fire or other catastrophes. Coral bleaching events have been increasing in both, frequency and extent, worldwide in the past 20 years. Global climate change may play a role in the increase in coral bleaching events, and could cause the destruction of major reef tracts and the extinction of many coral species.

The climate change is going to impact life support systems of the earth including our natural heritage in a significant manner. This will not only affect humans but also plants, animals and entire ecosystems. Global warming will lead to water and food shortages, increased frequency of floods and drought, rising sea level, more deaths due to malnutrition, disease and heat stress, extinction of species, and other related effects. Though, climate change will have disastrous consequences for millions dependent on climate sensitive sectors such as agriculture, forestry and fishery for their livelihood, developing countries, particularly poorer sections of society, are more vulnerable to climate change with little capacity to withstand adverse conditions.

INNOVATIVE PARTICIPATORY FOREST MANAGEMENT APPROACH FOR CLIMATE MANAGEMENT - A CASE STUDY OF GOVERNMENT FACILITATED COMMUNITY INITIATIVES IN CENTRAL INDIA

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The importance of Participatory Management Approach was recognized by the Government of India nearly 20 years ago when it included it in the National Forest Policy of 1988. The MP Government then made forays to operationalising it through its JFM resolution of 1995 in response to the GOI directives. The issue was implemented in the field through establishment of the JFM committees and introducing several changes in laws and rules and also the governance structure of the forest department to have a facilitatory rather than a policing role to forest Governance and Management. This approach has been greatly consolidated over the years and has been fully integrated into forest management activities at the household, village and national levels. In view of the multi-disciplinary nature of development in the rural sector a close collaboration between several departments, institutions and agencies along the chain from resources, to industry, trade, customs, finance, agriculture, forestry and food/health ministries has been initiated. This integrated approach of the Chhattisgarh government has enabled forests and forestry to play a much greater role in poverty alleviation. The success of this approach has set in place a process that has also been beneficial for Climate Mitigation Policies with the forest department and the communities playing a mutually reinforcing role in not only enhancing protection and conservation of forests leading to greater sustainable production of wood and wood products but also enabling the rural population to use alternative sources of energy like solar and biogas. The greater emphasis on better utilization of forest debris and wastes and their conversion into manure has also enhanced food production leading to greater food security at the local level. Thus the success of the JFM approach in the remote areas of the Chhattisgarh state has also silently set in motion a better climate management strategy based on sustainable forest management.

VULNERABILITY TO CLIMATE CHANGE IN SRI LANKA : ADAPTATION STRATEGIES AND LAYERS OF RESILIENCE

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Sri Lanka is vulnerable to climate change. As in other countries, its impacts are visible in human health, agriculture, water, ecosystems, wildlife, sea-level rise and extreme weather conditions. This paper reviews the current situation on vulnerability to climatic change in relation to the agricultural sector of the country. Agro ecological map which was developed in 1975 has been revised in 2003. Countries staple crop production has been continuously affected due to drought, floods, temperature rise, and sea water intrusion etc. Other important plantation crops such as tea, rubber and coconut, and other export agricultural crops such as cinnamon, pepper, cloves and cardamom etc. will have positive or negative consequences due to climatic change. Other subsidiary food crops could also be affected. Possible increased frequencies of these climatic changes can decline agricultural productions and lead to decreases in real incomes as current food prices go up. Rural sector paddy farmers have shifted from farming, resulting in about 63% of their mean household income coming from non-agricultural activities. As a consequences of all these impacts the country has faced a severe food scarcity and decrease in real incomes as food prices go up rapidly. For the small marginal farmer, vulnerability to climatic change can mean indebtedness, loss of land, etc. Impacts on women farmers will be adverse because of their traditional role as collectors of water, fodder and fuel.

As adaptation strategies, the following steps can be suggested. Efficient water management in farming situations, use of micro irrigation systems, rehabilitation of large, medium and small water tanks, streams and dams, recycling of waste water if usable, follow soil and water conservation techniques, recommendation of crop by agro climatic zones, breeding of new varieties resistant to drought, pest and diseases, salinity, high temperature, and introduce short-age varieties, launch awareness programmes and reinforce environmental laws and regulations to the maximum level.

LIVELIHOODS AND LANDSCAPE STRATEGIES FOR SUSTAINING BIODIVERSITY CONSERVATION, ENSURING FOOD SECURITY AND NEGATING CLIMATE CHANGE IMPACT IN SOUTH ASIA

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The developing nations of South Asia are confronted with plethora of social, economic and environmental problems. The most pressing and immediate concern for these nations is the mounting threat from climate change. These developing societies which are already struggling with rising population, severe poverty; food insecurity and declining natural resources consequentially become highly vulnerable to climate change. South Asia is the home to more than 40% of the world's species and their habitats but rising anthropogenic pressure has led to an unprecedented loss of biodiversity leading to impoverished societies. The very factors like poverty and economic divide contributing to the loss are the immediate consequences too. These social, economic and conservation issues are so intricately webbed that enduring solutions for one cannot come at the stake of other. The current programmes and policies have been addressing the above issues but they lack an integrated approach to provide sustainable solutions. IUCN's Livelihoods and Landscapes strategy is a concerted effort integrating biodiversity conservation and livelihood security. The present paper highlights the complexity of these issues, and presents a unique Livelihoods and Landscapes strategy for poverty alleviation, aligning field based action with national policy efforts. It highlights the crucial role of biodiversity and ecosystems in climate change adaptation and importance of capacity building for ensuring food security. It further discusses how strategies based on this approach can help restore ecosystems, conserve biodiversity and promote unique livelihood opportunities for the most vulnerable communities. Finally, the paper provides an insight into policy and institutional arrangements advocated by IUCN in context of biodiversity conservation, food security, and poverty alleviation subsequently aiding dual adaptations to climate change.

CLIMATE CHANGE & DEVELOPING NATIONS

Huma Mustafa Beg

Serendip Productions, Pakistan

Pakistan enjoys a unique and diverse landscape with sea shores in the south, high mountains and forest in north and desert lying between the fertile plains. With this diversity comes a propensity towards natural hazards that is increasing with the rise in global temperatures. The potential for natural hazards is further fuelled by poverty of the people and a weak system of governance.

Environment protection has largely been deemed a peripheral issue and de-prioritized in the natural development plans. But with the emergency of climate change the inter-relation between the country's ecological health and its economic and social wellbeing is finally surfacing and threatening to destabilize almost all developing processes of the country. Pakistan is more susceptible to the effect of changing climate because of its agrarian base and high dependency on the natural resourses for livelihood. Agricultural productivity has already started to plunge with the impact of altering weather conditions and transforming land and water resources. We are witnessing a reduction in annual crop yields brought on by various factors including increased water logging, desertification of land, growing frequency of pest attacks and disaster. Projections for future water availability scenario are mixed; on one hand reports by the Intergovernmental Panel on Climate Change (IPCC) suggests that Pakistan will receive higher levels of rain fall with the increasing temperatures, but storms and floods resulting from the increase in precipitation coupled with irregularity of water distribution will most probably off set the benefits of receiving more rainfall. A significant vulnerability factor for Pakistan is the threat of global warming to our human settlements in Coastal Areas. Rising sea levels coupled with the increasing precipitation in some regions threaten to wreak havoc on many coastal towns and cities and can even possibly submerge them underwater.

These worst case scenarios can still be averted if the right action is immediately taken. The challenge for Pakistan like the rest of the world is to develop responses that are serious and effective and suited to regional situations.

CLIMATE CHANGE, BIODIVERSITY AND FOOD SECURITY IN THE SOUTH ASIAN REGION

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The Projections of Climate Change Impact in South Asia are glacial melt in Himalayas to cause increased flooding, reduction in availability of fresh water, changes in precipitation to have major implications for agriculture and risk of hunger. The 2005 downpour in Mumbai made virtually week long halt for the entire city and such events are likely to increase in future. The impacts of climate change on biodiversity are change in distribution of species, changes in length of growing seasons for plants, increased extinction rates of species and changes in reproductive timings. The future strategies for combating global warming include regional and national Initiatives on climate change; adaptation & mitigation; sustainable forest management, reforestation & afforestation; assisting farmers in coping with current climatic risks; enabling policies and regional cooperation; strengthening research for enhancing adaptive capacity; improving collection and dissemination of weather related information; providing financial incentives for resource conservation and securing finances and technologies for adaptation. Impact of Climate Change is likely to be felt most severely in developing countries like India because of resource and infrastructure constraints. The macro strategy may be rapid sustainable and equitable development that will increase income levels, education and technical skills, improve food distribution, disaster preparedness and management, health care systems and reduce vulnerability. Micro Strategy involves the management of sectors most sensitive to the climate change. This means developing new institutions or modifying existing ones to promote adaptation to climate change

CLIMATE CHANGE - MITIGATION AND ADAPTATION

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India is a large developing country with nearly 700 million rural population directly depending on climate-sensitive sectors (agriculture, forests and fisheries) and natural resources for their subsistence and livelihoods. The increase in average global temperature is a major factor for climate change and this change in climate affects different aspects of our lives like agriculture, water resources, forestry and natural resources, human health, sea level rise, etc. This impact would be particularly severe in the tropical areas, which mainly consist of developing countries, including India. Climate change is one of the most important global environmental challenges facing humanity with implications for food production, natural ecosystem, freshwater supply, health, etc. Since the end of 19th century the earth's average surface temperature has increased by 0.3-0.6^{0}C. Over the last 40 years, the rise has been 0.2-0.3^{0}C.The Intergovernmental Panel on Climate Change (IPCC) projects that the global mean temperature may increase between 1.4 and 5.8 ^{0}C by 2100. This change in climate is linked to an increase in the concentration of green house gases (GHG) such as CO_2, methane, nitrous oxide, chloroflouro carbons, hydro flouro carbons and per flouro carbons. GHG emissions have grown since pre industrial times with an increase of 70 per cent between 1970 and 2004.

There are two dimensions in response to the global warming - Mitigation and Adaptation. Mitigation is cutting down emissions of global green house gases and it can reduce the extent of climate change. According to IPCC fourth assessment report on mitigation if there is no change in the energy policies, the energy mix supplied to run the global economy in the 2050-30 time frame will essentially remain unchanged with more than 80 per cent of energy supply based on fossil fuels with consequent implications for GHG emissions. There are several approaches that can assist in reducing GHG emissions. Clean Development Mechanism (CDM) i.e absorbtion of carbon by afforestation or reforestation is very important for developing countries like India. Improved varieties of crops, improved water and fertilizer management in paddy, improved livestock and their

diet can also add to reduce GHG emissions. Since climate change is now an inevitable prospect that is why India is especially vulnerable to the adverse impacts of climate, and over 2 per cent of GDP is currently spent on measures to adapt to these impacts. Improved physical infrastructure can afford some protection against phenomenon associated with climate change such as floods, extreme weather events or coastal erosion. Adaptation is necessary to address impacts resulting from the warming which is already unavoidable due to past emissions. Global climate change has considerable implications on Indian agriculture and hence on our food security and farmers livelihood. So we need to take steps to increase our adaptive capacity.

POLICY FOR SUSTAINABLE FOREST DEVELOPMENT FOR INCREASING CARBON SINK AND MITIGATING CLIMATE CHANGE

Bala Prasad

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According to an assessment, there was 3.454 billion ha i.e. 26.6% of total landmass area of world in 1995 under forest cover and about 57% of the forests were in developing countries. Though, we have been losing forests over the years across the world, but in nineties developed countries have been able to reverse the trend whereas developing countries continue to lose forests. The annual rate of the loss of forests in the world were estimated to 11.21 million ha in total where as the annual rate of loss in developing countries was 13.03 million ha. To reverse the trend of continuous loss of forests in developing countries Sustainable Forest Development (SFD) has emerged an important tool. In its famous report titled "Our Common Future," World Commission on Environment and Development defined sustainable development as "economic development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Following this definition SFD may also be defined as the forest management practices that meet the needs of the present population without compromising the future and ecological diversity of these forests. Thus, SFD must ensure well stocked, socially beneficial, environmentally benign and economically viable forests. SFDs have been successful at many places in rejuvenating even degraded forests

Global warming leading to climate change is becoming real problem before contemporary society. The latest reports of Inter Governmental Panel on climate change proved its disastrous consequences beyond any reasonable doubt. Climate change is likely to alter the distribution and quality of natural resources and adversely affect livelihood systems. The climate – sensitive sector e. g. agriculture, horticulture, forestry may face major threats due to climate change. It may also affect food production and food security, particularly of poor people. There have been efforts for reduction of emission of Green House Gases (GHGs) in accordance with the Kyoto Protocol. It was also found that there was decrease in the emission of GHGs in the last few year of twentieth century in developed

countries. But, recent data showed that emission of GHGs in the developed countries actually rose between 2000 to 2005.

In this context comprehensive policy analysis has been carried out in conceptual framework, in the paper. Further, on the basis of the analysis, new / modified consistent policy components have been identified and detailed in the paper. It was found that though forestry provides the most important tool for carbon sequestration, it is not at the central stage of climate change mitigation strategy. Due to cumbersome processes, only one Project Design Document (PDD) of Forestry has been approved till date. Moreover, vast area are under shifting cultivation and hot and cold deserts. Even in the existing forest area, total growing stock and biomass and thereby corresponding carbon is less than their carbon absorption potentiality. In some countries even definition of forestry is turning out as deterrent for forestry PDD. Therefore, there is need to act as responsible global citizen and promote SFD with focus on carbon sequestration and adopt simplified forest friendly project designing framework for increasing carbon sink. Supporting meticulous project formulation of forestry PDDs and their implementation and comprehensive monitoring may turn out to be most important tool for retrieving climate change. Hopefully the strategic shift in the policy would go a long way in reducing GHGs from atmosphere and mitigating climate change.

CLIMATE CHANGE AND BIODIVERSITY

CLIMATE CHANGE AND BIODIVERSITY IN INDIA

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India is one of the 12 mega biodiversity countries of the world as well as the second-largest populated country in the world. A majority of its population still directly depends on biological resources for their livelihood. With only 2.5% of the total land area, India accounts for 8 % of the recorded species of the world which includes countless millions of races, subspecies and local variants of species and the ecological processes and cycles that link organisms into populations, communities, and all different ecosystems. The wide variety in physical features and climatic situations have resulted in diversity of ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and desert ecosystems which harbour and sustain the immense biodiversity. India is very rich in terms of biological diversity due to its unique bio-geographic location, diversified climatic conditions and enormous eco-diversity and geo-diversity. India embraces three major biological realms, viz. Indo-Malayan, Eurasian and Afro-tropical and is adorned with 10 bio-geographic zones and 26 biotic provinces. Humans largely depend on less than 9000 plant species for food, clothing, shelter, medicines, forage and industry. Of these, about 900 species have been domesticated for agriculture. Of these 900 only about 168 species are most commonly cultivated for food and agriculture. In India agriculture and industries use several species of bacteria, fungi, algae, plants and animals. Due to change in the climate pattern in recent decades as well as with increasing industrialization and human dependence on biodiversity, many species are decreasing at an alarming rate. Due to the significant dependence of local people and economies on biodiversity in India, there is a need to monitor the possible impacts of climate change on biodiversity and develop conservation measures at all levels in India. This paper gives an over view of the richness of biodiversity in India and their importance for conservation in the perspective of climate change.

IMPACT OF CLIMATE CHANGE ON BIODIVERSITY: THE HUMAN DIMENSION

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The global change initiated at the beginning for the last century due to rapid industrialization and the land use change has a profound impact on different ecosystems on the earth. The ecological footprints of man have permeated to most of the regions of the earth and is expected to increase as a result of climate change due to dwindling of the resources. The loss of the forest cover as a result of climate change along with deforestation is systematically increasing the ecological foot print of the humanity as the ecological benefits of the deforested area have to be taken up by the remaining vegetated areas.

Biologically diverse ecosystems apart form providing the basic ecosystem services like climatic stabilization and carbon sinks are also a vital resource for technological development in agriculture, pharmaceuticals and other technological innovations. The loss of biological diversity reduces the ecosystems ability to adapt to the change. The need of the hour is a systematic spatial and temporal monitoring of the biological diversity and the intensity of pressure on the biological resources. Geo-statistical analysis of the species/community shift due to environmental gradients as well as incorporating geo-spatially tagged socioeconomic data will give us an insight into the influence of socio-economic factors on the biodiversity change and ultimately model the scenario.

The national level biodiversity characterization at landscape level is being carried out by Department of Biotechnology and Department of Space to map the areas of potential biological richness using a combination of satellite based vegetation type maps, ground sampling and geospatial modeling. Presently around 15000 geospatially tagged phytosociological records have been collected across the different vegetation types covering ca. 80% of the forested area of the country. This database will serve as the baseline data for future studies to understand the impact of climate change on biological diversity.

IMPACT OF CLIMATE CHANGE ON TREE SPECIES DIVERSITY OF HILL FORESTS OF BANGLADESH

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The composition of tree species in natural forest is changing in hill ecosystem of Bangladesh. Study on the new recruitments, the old predominant and dominant tree species was conducted and found significant sift of the species which show the comprehensive evidence of impact of climate change. The dominant and predominant economically important forest tree species were found in the natural forest as follows: *Dipterocarpus turbinatus* (IVI-41), *Anthocephalus chinensis* (IVI-39), *Michelia champaca* (IVI-21), *Cassia fistula* (IVI-20) and *Lagerstroemia speciosa* (IVI-19). On the contrary, the major naturally regenerated economically important forest tree species were found as follows: *Syzygium cumini* (IVI-113), *Lagerstroemia speciosa* (IVI-16), *Syzygium fruticosum* (IVI-13), *Dipterocarpus turbinatus*(IVI-22), *Terminalia belerica* (IVI-9) and *Cassia fistula* (IVI-7). Very surprisingly, *Michelia champaca* a prominent forest tree species was not found in the sampled areas, which indicate there may be existence of unsuitable factors for regeneration including climate. The pattern of natural regeneration indicates a change of future scenario of the hilly natural forest ecosystem, which may lead to a low economic forest zone. This is not going to help alleviate poverty of the country. This leads a situation to conclude that economically and ecologically viable natural hill forests of Bangladesh may not be sustainable in the long run due to changing climate.

THE IMPACT OF CLIMATE CHANGE AND THE HIMALAYAS IN THE LOCAL CONTEXT: THE CASE OF NANDA DEVI BIOSPHERE RESERVE

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There have been very little scientific studies on the impact of climate change on protected areas of the Himalayan mountains and studies specific to the Nanda Devi Biosphere Reserve (NDBR).The NDBR is one of the most important protected areas of the central Himalayan ecosystem and was included under the UNESCO's world network of BRs in 1982. The site is also a UNESCO world natural heritage site with Valley of Flowers being part of the system. The BR consists of a vast area under its buffer and transition zones including around 37 villages and the towns of Hemkund Sahib, Badrinath and Joshimath.

General research in the Himalayan region has shown that the glaciers are diminishing at a faster rate than any other region in the world. These melting glaciers will initially lead to severe floodings within the coming two to three decades and eventually to a decrease in the annual discharge of the mountain rivers. Thus, if continued at the the same rate, this decrease will eradicate the livelihoods of communities living in the area and seriously limit the water supplies to those depending on the water from the rivers further downstreams. These rivers, which are some of the worlds largest river systems, are the major contributers to the water supply of agricultural, industrial, commercial and domestic use of the non-peninsular parts of India. Therefore, it is crucial to take strong measures towards sustainable water management. Further, the impact of climate change on soil erosion and sedimentation, even though indirect, is predicted to be significant.

The change in climatic conditions would have direct biological and socio-economic implications for NDBR and the surrounding areas. For instance, the economic impacts of diminishing natural resources, particularly of the river systems, due to climate change, will have adverse impact on the infrastructure, tourism, the agricultural sector, as well as the degradation of forests, vegetation and hydro power. Additionally, climate change can result in enhancing biological invasions and land degradation.

Biological invasion is a real threat to the biodiversity of NDBR, as shifts in climatic condition would have a direct impact on flora and fauna. Himalayan forests can be particularly pressured by the combination of climate change effects and the increasing population pressures of the area. Due to micro-climate variations in the Himalayan mountain ranges, climate change research needs to be conducted at a micro level, so as to create better understanding of the complexity of the implications both for the environmental and socio-economic situation.

These implications are deeply rooted in the human interactions with their environment. In order to manage and improve these interactions in a sustainable manner, policies are needed at the local/regional/national levels. In the local context of NDBR, finding adaptation measures to the climate change effects and succeptibilities will be the best strategy to conserve the exceptional biodiversity of the area while promoting sustainable development. The local traditional knowledge and the practices based on the sustainable use of natural resources and biodiversity can provide the basis for appropriate adaptation strategies to cope with the challenges of climate change in the NDBR and the whole Himalayan region. In this context, NDBR, could be an excellent leading ground for finding and developing adaptation strategies for both the local and regional Himalayan context. Adaptation strategies for conservation and development purposes are needed for this specific area, therefore more knowledge needs to be gathered on which to base relevant descisions and policies for preservation of this area.

CLIMATE CHANGE DUE TO GLOBAL WARMING AND ITS IMPACTS ON PLANTS AND BIRD MIGRATION IN INDIAN SUBCONTINENT

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Global climate change is an integral system of several atmospheric phenomena. Recent economic growth (GDP) has been a powerful means for socio economic progress and raised to 9.5 % and 10.0% G.D.P. in India and China respectively that has changed the climate, carbon cycle, global warming, water quality, acid rain (air pollution) and biodiversity which is affecting food security system.

Anthropogenic activities and acid rain around Jubilant Organosys Ltd. (JOL), Industrial Estate of Gajraula (J.P. Nagar) U.P., India have been observed which showed significant decreasing effects on height of plant, no. of tillers plant^{-1}, leaf size, stomatal index, leaf extract pH and chlorophyll content of *Pennisetum glaucum* (L.) R. Br. Necrotic patches on leaves of *Oryza sativa*, *Cycas*, Palm tree, blackening of mango fruits and corrosive effects on building and iron as well as on honeybee and birds nests have been studied. Meteorological data have been discussed for climate change by rising temperature and changing of ambient rain pattern and late arrival & early departure of migrating bird in Indian Sub continent.

IMPACT OF CLIMATE CHANGE ON FISH PRODUCTION IN INDIA

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Climate change has both direct and indirect impacts on natural and commercially exploited fish stocks. Direct effects include alterations in physiology, behaviour, growth, reproductive capacity, mortality and distribution. Indirect effects alter the productivity, structure and composition of marine as well as freshwater ecosystems on which fish depend for food. Considering the enormity of the problem and the need to address the issues connected with climate change and marine and freshwater fisheries including food security and livelihood, researchers have revealed that fishes are changing their distribution very rapidly due to increase in temperature. The other factors responsible for the decline of fish production are fall in nutrient level, over fishing, loss of wetlands and nurseries & breeding grounds, pollution, loss of genetic diversity, habitat destruction, introduction of exotic species and pathogens. It is observed that as northern latitude is becoming warmer, the Oil Sardine, which is essentially a tropical fish species, is establishing itself in the new territories. Decline in river flow levels is further making the fishes vulnerable to death & decay and the declining fish yield. The consequences of major fluctuation in fish stocks have had major economic and food security threat for human societies. For communities who heavily rely on fisheries, any decrease in the local availability or quality of fish food may pose big threat to their livelihood in the years to come.

WINTER FLUCTUATION IN RUDDY SHELDUCK (*TADORNA FERRUGINEA*) POPULATION OF ASAN CONSERVATION RESERVE, DEHRADUN, UTTARAKHAND

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The Asan Conservation Reserve (30º 25' 60" N and 77º 42' 00"E) covering an area of 445 ha is situated 40 km west of Dehradun. It is an important Bird Area (IBA Site Code: In-UT-01) and country's first conservation reserve. Every year many intercontinental migrants come to Asan Conservation Reserve (Asan CR) from their breeding grounds to spend their winter for food and shelter. The Ruddy Shelduck (*Tadorna ferruginea*) is one of the dominant winter visitors to Asan CR. The fluctuation in Ruddy Shelduck population during winter months of 2005 to 2008 was observed. The fluctuation was attributed to the raise in atmospheric temperature during winter months of 2006 to 2008. The Ruddy Shelduck population was significantly correlated with maximum temperature ($r = -0.58$, $P = 0.01$) and minimum temperature ($r = -0.64$, $P = 0.01$). The study reveals the impact of local climate change on Ruddy Shelduck population of Asan CR.

WETLANDS AND CLIMATE CHANGE

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Wetland ecosystems are the repositories of rich genetic diversity in terms of floral and faunal composition and are constantly under threat due to natural as well as anthropogenic influences. There are three wetlands of International importance in Punjab state and these demonstrate a wide range of ecological functions and values. With changing climatic conditions the impact on these ecosystems also needs to be ascertained. The rising temperatures have an impact on complex aquatic chemistry and also on the biological processes therein. The available dissolved oxygen, dissolved solids and as such the sensitivity to rising temperatures forces some species to shift and migrate upwards towards the cooler waters. Besides this, the untimely rain and the fluctuations in precipitation also lead to surge in physical as well as chemical pollutions. This can have a significant impact on fish breeding, and the avian migration in wetland ecosystems.

IMPACTS OF CLIMATE CHANGE ON WETLANDS

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Changes in the atmospheric concentrations of GHGs and aerosols, land cover and solar radiation alter the energy balance of the climate system and are drivers of climate change. As per the recent Inter-Governmental Panel on Climate Change (IPCC) report, global green house gas (GHG) emissions have grown by 70% between 1970 and 2004 (4th IPCC Assessment Report, 2007).

For Indian scenario, a general trend of increase in precipitation and temperature has been predicted. Spatial patterns of rainfall change indicate maximum increase over west coast and northeast India. It has been estimated that there would be 20% rise in all India summer monsoon rainfall in future scenarios except in Punjab, Rajasthan and Tamil Nadu which would show slight decrease in precipitation.

Wetlands, estimated to cover about 6% of the earth's terrestrial area provide invaluable services and benefits for human populations including the regulation of climate. Climate change would threaten wetlands in a number of ways. Increased temperatures would adversely affect temperature sensitive plant and animal species. Decreased precipitation in wetland areas would result in shrinkage of wetlands that will release more carbon into atmosphere due to decay of organic matter. Climate change may also lead to shifts in the geographical distribution of wetlands. Moreover, wetlands are highly dependent on water levels, so changes in climatic conditions affecting water availability will influence the nature and function of specific wetlands including the type of plant and animal species. Climate change, therefore, is an important issue for wetland management. Conservation and wise use of wetlands can no longer be achieved without taking climate change into account.

The present paper primarily brings out possible impacts due to climate change in relation to Ramsar sites of Punjab (Harike, Kanjli & Ropar). Initially, there may be increased frequency and magnitude of freshwater floods due to melting of glaciers. The impacts could be loss of property and lives, water pollution by way of overflow of sewage systems and damage to agricultural areas. Subsequently due to rising temperatures &

less rainfall there may be increased frequency and magnitude of droughts. The impacts could be decreased food production, loss of ecosystems & biodiversity and thereby decline in migratory birds. Harike would be the worst affected wetland.

SHISHAM MORTALITY AND ITS CORRELATION WITH CLIMATE CHANGE

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The climatic conditions are changing rapidly affecting the atmospheric chemistry, vegetation, crops, monsoon, snow cover on the earth's poles and melting of glaciers. The people are experiencing erratic rainfall, drought and extreme weather conditions. The problem of air pollution has attracted attention in India due to its effect on population, industrialization and urbanization. In the forest sector the health of trees is deteriorating and unusual mortality is experienced in different agroclimatic zones and in different tree species. The existence of "Asian Brown Haze" over India has been established by Indian Ocean Experiment (INDOEX) conducted by United Nations Environmental Programme (UNEP). Huge quantities of green house gases particularly CO_2 and methane are emitted by transport and power sectors. Other pollutants recorded by the INDOEX team were Carbon monoxide, dust particles, water vapors and aerosols. The brown haze has covered northern India from Jammu & Kashmir to West Bengal and finally descending down in the Bay of Bengal.

Ground surveys in Jammu & Kashmir, H.P., Punjab, Haryana, Delhi, Uttarakhand, Uttar Pradesh, Bihar and West Bengal confirmed low to high mortality in shisham trees of all age groups. Very heavy mortality, over 70% was reported from Phillour, Bhatinda, Patiala and Amritsar in Punjab, Bhiwani and Yamuna Nagar in Haryana, Deoria, Kushinagar, Ballia and Aligarh in Uttar Pradesh and Sitamarhi, Motihari, Madhubani, Betiah, Siwan, Chapra and Muzzaffarpur in Bihar and Mejia (Durgapur) in West Bengal. As per a rough estimate more than four lakh trees have died incurring losses over rupees one thousand crores in India. Neighbouring countries like Pakistan, Bangla Desh and Nepal were also affected by the disease. The studies on Asian Brown Haze were undertaken by UNEP since 1995 and mortality started appearing after the year 1998. The areas outside haze were found free from mortality. The correlation of climatic change with tree mortality, which is first of its kind, is discussed.

KUNTBHYOG LAKE : BIODIVERSITY, CONSERVATION AND ITS DESIGNATED USE

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Himachal Pradesh has enormous aquatic resources in terms of upland rivers, streams, high and low altitude lakes, man made lakes, reservoirs in the Himalayan region viz. Suraj tal, Chandra tal, Prashar, Manimahesh, Gobindsagar, Mahakali lake, Pong dam, Dal lake, Kuntbhyog and Rewalsar which are rich in biodiversity. Due to increasing demand of water, wetlands are under severe pressure, thus threatening the biodiversity therein. In the absence of information about their biodiversity regarding distribution, population dynamics and species composition, a successful plan for their conservation and management can never be framed. It was in this direction; that present study was planned and carried out on Kuntbhyog lake in district Mandi of Himachal Pradesh. Kuntbhyog lake is situated (31°37'N; 76°49'6"E) at the beautiful hilltop of Rewalsar town at an altitude of 1750 m above msl. This is geologically oldest lake and there are possibilities of supporting a diverse aquatic life (phytoplankton, zooplankton, fishes and benthos).

The average and range of various physico-chemical factors of the lake water were: water temperature (°C) 18.891 ± 5.244 (8.60-24.50), penetration of light (cm) 35.375 ± 8.420 (20.50-49.00), turbidity (NTU) 12.997 ± 2.141 (8.02-16.40), electrical conductivity (μs/cm) 76.167 ± 5.605 (69.00-90.00), dissolved oxygen (mg L^{-1}) 8.013 ± 1.492 (6.45-11.10), BOD (mg L^{-1}) 2.679 ± 0.492 (2.00-3.20), free CO2 (mg L^{-1}) 11.166 ± 1.800 (8.00-14.00), pH 8.170 ± 0.867 (7.08-9.78), alkalinity (mg L^{-1}) 36.583 ± 29.910 (10.00-90.00), total hardness (mg L^{-1}) 79.833 ± 3.512 (73.00-85.00), Ca++(mg L^{-1}) 52.415 ± 5.680 (45.00-64.00), Mg++ (mg L^{-1}) 27.25 ± 5.396 (20.00-37.00), chlorides (mg L^{-1}) 13.25 ± 1.400 (10.20-15.32), nitrite (mg L^{-1}) 0.258 ± 0.149 (0.13-0.50), nitrate (mg L^{-1}) 1.101 ± 0.721 (0.15-2.00), ammonia (mg L^{-1}) 0.964 ± 0.673 (0.13-1.90), T.D.S (mg L^{-1}) 48 ± 14.560 (30.00-78.00), sulphate (mg L^{-1}) 79.155 ± 3.465 (25.00-115.00) , Phosphate (mg L^{-1}) 1.587 ± 0.335 (1.00-2.2.0) and Silicate (mg L^{-1}) 5.833 ± 1.026 (4.20-7.00).

The plankton of common occurrence were: *Microcystis aeruginosa* , *Oscillatoria* spp., *Ulothrix* spp., *Pediastrum duplex*, *Cosmarium* sp., *Closterium tumidium*, *Scenedesmus acutiformis*, *S. qudricauda*, *S.*

bijugatus, *Coelastrum cambricum*, *C. microsporum*, *Closterium* sp., *Euastrum* sp., *Ankistrodesmus* sp., *Nitzschia* sp., *Cymbella* sp., *Navicula* spp., *Euglena* sp., *Phacus* sp. among phtoplankton; *Brachionus calyciflorus*, *Keratella tropica*, *Daphnia* sp., *Cyclops* sp. among zooplankton, and common fishes species encounted were : *Cyprinus carpio communis*, *Cyprinus carpio specularis* and *Tor putitora*. Among phytoplankton, members of Bacillariophyceae and Chlorophyceae constituted the dominant component, whereas Cyanophyceae and Euglenophyceae constituted the subdominant component. Among zooplankton, Rotifera, and Artropoda formed the dominant component whereas Protozoa and Ostracoda were rare in occurrence. The planktons showed abundance during summer and minimum number in winter. Relatively higher values of temperature, conductivity, penetration of light, alkalinity, hardness and nutrients were the factors responsible for plankton abundance in summer, whereas high turbidity, cloudy weather and dilution in the concentration of salts during monsoon were associated with minimum number of plankton.

On the basis of the values of Shannon's species diversity index, maximum species richness was observed in summer, and minimum in winter. Further, Chlorophyceae and Rotifera among zooplankton showed maximum species diversity. On the basis of the values of primary productivity, chlorophyll and Nygaard's Trophic state index, the trophic status of the lake was found to be meso - eutrophic. By analysing physico-chemical characteristics of water and according to the classification of waters for various purposes given by Central Pollution Control Board (CPCB), the water of the lake could be categorizing as B.

ECOLOGICAL THREATS FROM ALIEN INVASIVE PLANTS IN HIMACHAL PRADESH, INDIA

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Biological invasion especially in the tropics was rightly anticipated as a major problem of the environment about two decades ago by the scientific committee on problems of the environment. Invasion occurs when species move from one geographical region to another, where they establish, proliferate, and persist. Invasions get facilitated by change in climate resulting from atmospheric warming, changed wind pattern and velocity, distribution of propagules and the like. Invasion by the alien plants has a strong link to the distribution and diversity of native vegetation. This in turn, has a direct bearing on the dependent insects, pests and other fauna, thus the overall biological diversity. Biological invasions have caused more species extinctions than did human-induced climate change and are the second leading cause of species extinction, after habitat loss. The invasion of native ecosystems by alien species can lead to alterations in nutrient cycling, water regime, hydrology, energy budgets, and native species abundance and survival. India, with three biodiversity hot spots, because of obvious reasons, is among the most potential regions of plant invasion. However, unfortunately in the absence of the any baseline data on alien plant invasion it is difficult to establish the rate of invasion and status of exotic species. The proposed presentation deals with the alien plant invasion in Shiwalik range of Himachal Pradesh Himalayas. It focuses on the three tropical American noxious weeds namely, *Lantana camara*, *Parthenium hysterophorus* and *Ageratum conyzoides*. It also discusses the reasons of fast invasion threats in the region.

QUANTITATIVE AND QUALITATIVE ANALYSIS OF RIPARIAN VEGETATION AT UTTARKASHI, GARHWAL HIMALAYAS, INDIA

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A riparian area describes immediate surrounding of watercourses where water strongly influences immediate ecosystem. These areas play a pivotal role in the connectivity of terrestrial and aquatic ecosystems. This study is aimed at qualitative and quantitative analysis of riparian plant species diversity and its distribution pattern on both banks of Bhagirathi-Ganga River, at Uttarkashi city of Uttarakhand state in Garhwal Himalayas of India. A total number of 78 riparian plant species belonging to 47 families and 58 genera were documented and identified. It has resulted from the data analysis that *Pinus roxburgii* (2.10/ 100m^2) and *Dalbergia sissoo* (1.20/ 100m^2) were found highest dominant tree species, at left and right bank of the river, respectively while among the shrubs *Urtica dioica* was dominant on the both banks. *Arundinella nepalensis* (4.10/m^2) and *Imperata cylindrical* (5.10/ m^2) were observed dominant herbs species for left and right banks, respectively.

NEMATODES AS BIOINDICATORS OF CLIMATE CHANGE

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Soil nematodes are considered as one of the key agents in important soil processes, such as decomposition, mineralization and nutrient cycling. Climate change will not have a rapid influence on the composition of the nematode fauna, however the soil structure and vegetation will change and this will definitely influence the nematode fauna and therefore alterations of the nematode community induced by climate change will have a considerable influence on ecosystem functioning. Significant studies on the effects of climate change on nematodes have been carried out in the extreme climatic conditions like that of McMurdo Dry valley of Antarctica. Antarctic climate cooling has shown changes in diversity of soil invertebrates and decline in the abundance of one of the dominant nematode species *Scottnema lindsayae*. Also warmer temperatures will lead to a decline in nematode population as the heat drives the soil moisture which is important for the existence of nematodes in the soil. Nematodes are potentially good bioindicators of climate change because they react sensitively and predictably to microclimate conditions and therefore coenological analysis of nematode fauna appears to be useful tool for the biological monitoring of the effects of climate change.

INTERTIDAL MACROINVERTEBRATES OF SUBARNAREKHA ESTUARY (BALASORE: ORISSA), THEIR ECONOMIC EVALUATION, TRADITIONAL USE AND CONSERVATION

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The subarnrekha estuary is situated almost in eastern part of the Orissa coast bordering West Bengal. This estuary comprises all sort of the estuarine habitats, i.e. tidal mud flat, sandy beach, patchy mangroves, marsh land, soft mud along the narrow creeks, etc. Whereas most of the estuary of the eastern coast of India were studied well in respect of faunal diversity, but there is no detailed study on the faunal resources of this estuary in respect of biodiversity as well as their potential economic evaluation or their sustainable use with proper conservation. Despite anthropogenic pressure and various types of fishing activities, this place is rich in faunal diversity. The author investigated the intertidal macro-invertebrate faunal resources of this area for the period of 2006-2008. Previously Chatterjee & Mitra (2003) reported the Estuarine Molluscs of Talsari and their socio-economic aspects. Mitra and Misra (2006) reported 106 species of Intertidal macrofauna from the talsari, the south-west part of the Subarnarekha estuary. The present papers deals with a comprehensive list comprising 152 species of intertidal macro-invertebrate fauna belonging to 105 genera, 72 families and 8 Phylum identified from this estuary. Among these groups, phylum mollusca is dominated (50 %) with a list of 81 species, crustaceans and polychaetes following the second and third major group, whereas phylum-Sipancula, Echiura and Brachiopoda represented by a single species only.

As some lower-invertebrates i.e. cnidarians, polychaetes, molluscs and some primitive artrhropods, like *Carcinoscorpious rotundicauda* has valuable bio-active compounds which are used in health industry , Special attempts were made to document the traditional uses of those species by local peoples with a comparison of their potential economic importance as per modern research , so the sustainable mariculture of those species may be promising for the economic growth of the local livelihoods and simultaneously conservation also succeded by proper means of their utilization.

ROLE OF BUTTERFLIES IN THE NATURAL ECOSYSTEM WITH SPECIAL REFERENCE TO HIGH ALTITUDE (PANGI VALLEY, HIMACHAL PRADESH)

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The importance of butterflies is many folds. Apart from being aesthetically attractive, they act as indicators to depict the health of a habitat. The larvae of butterflies are associated with plants but cause only little damage to the hosts. The adults act as incidental, wild pollinators and help in pollination of many native plants. The larvae as well as adults are food for many predators like lizards and birds. The butterfly diversity in an ecosystem tells how much healthy it is, as butterflies are very sensitive to any change in the environment. But in the present day scenario, many butterfly species are under a real threat due to depletion of the natural cover for various developmental activities. This is further exploited due to their use in insect trade. Pangi Valley situated in the upper part of Chamba, is the remotest and the most beautiful valley of Chamba district of Himachal Pradesh. It is a hidden valley located between Pir Panjal and the Greater Himalayan Zanskar ranges. During late summer, the valley is opented through several difficult passes. During winter and spring this valley is completely cut off. It comprises valley of Chanerbhaga through a distance of nearly 85 kms from Karru Nallah to Sansari Nallah. During the course of present studies the butterfly diversity of Pangi valley has been assessed and twenty two species have been collected from various areas. The nectar food plants of ten species have been recorded for the first time and new larval host plants of two species viz., *Vanessa cardui* and *Pieris brassicae* have also been observed.

HABITAT DETERIORATION OF FRESHWATER TURTLES IN BANGANAGA (HARIDWAR AND AROUND, UTTARAKHAND, INDIA) A CASE STUDY

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In India, turtles and tortoises play a very important role as religious symbols, in folklore and culture. Out of 28 species of Chelonians found in India, 5 species belong to sea and rest to freshwater and land chelonian. The Indo-Gangetic plain and the Terai region has a diverse chelonian fauna with the occurrence of 20 species of freshwater turtles and tortoises. This species richness and diversity in India has both national and global significance. Freshwater turtles play a very important role in cleaning of freshwater. They are scavengers on human dead bodies as well as dead animals. Thus they maintain the water healthy, which is essential not only for them to survive but also for other aquatic animals like otters and fishes. They (unscheduled species) are also a food source for poor people. They have medicinal values too, that require further research to know how useful they are in curing human diseases. The ecological studies done in present paper noted the fragmentation and deterioration of habitat of freshwater turtles (localities Lalpur, Jwalapur; near Haridwar, Uttarkhand, India) due to various factors including dam construction and rise in ambient atmospheric temperature of Haridwar and around. The habitat destruction further increases the pressure on the existence of various freshwater turtle species including *Leissymus punctata punctata* (Lacepede), North Indian Flap -shelled turtle (listed under India Wildlife protection Act 1972, Schedule I) as they are prone to poaching. Blood samples of the species from the area were collected for molecular (DNA) study to know the population variation. In the field some of them are reintroduced in healthy habitat. Freshwater turtles can be a flagship species that can ultimately preserve habitats that not only benefit turtles but also other mega species of Ganga river dolphin, otters, crocodiles and wetland birds including several endemic fishes. Fresh water turtles as a food source have also been discussed.

IMPACT OF CLIMATE CHANGES ON THE BIODIVERSITY OF MANGO (*MANGIFERA INDICA* L.) IN PUNJAB, INDIA

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A large population of mango seedlings is found growing on isolated areas of sub mountane zone including kandi area of Punjab (India). Impact of global warming has been observed during survey of mango growing areas of district Hoshiarpur. It has been observed that area under mango plantation for the last few years has declined from 11,581 ha in 1990-91 to 6450 ha in 2007-08 due to erratic rainfall, variation in day and night temperature, recurring of heat waves and frost, receding water table, population pressure, shifting of cropping pattern and increasing developmental works in the region. During these processes, many elite mono embryonic elite mango seedlings germplasm known to possess desirable horticultural traits has been lost or is at the verge of extinction. The existing mango seedling population not only contributes to the biological diversity and in meeting nutritional requirements of local population but also has a great potential for further utilization in crop improvement programmes. Indigenous heritage of seedling mango populations growing on roadsides, isolated places, government lands, protected and restricted areas marked by the State Forest Department under section 4 & 5 needs to be conserved so that superb quality fruit plants can be saved from extinction. In future, regular monitoring and surveillance of seedling mango tracts growing in different nooks and corners of this acclimatized region of Punjab should be carried out. These location specific genotypes need to be identified and further evaluation under different ecological zones be done to develop good mango varieties.

MEDICINAL PLANT DIVERSITY AMONG SOME SELECTED SITES OF UTTARAKHAND

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Wild floras are the major source of ethano-medicinal products for curing various ailments. Indian traditional medicinal system was entirely dependent on plant diversity. People have been using plants, having diverse medicinal values directly or indirectly in the form of leaves, roots, shoot and extract, for a long time. World health organization (WHO) also pointed out that approximately 80% population of the world is dependant on traditional herbal medicines. In remote areas of Uttarakhand, folk medical prescriptions are endemic but survived through ages from one generation to the other. Indigenous systems of medicine are specially conditioned by the cultural heritage treaties like Vedas and Samhitas etc. With a deep concern and reverence for the vast plant diversity of Uttarakhand that our country enjoys and with sense of realization about the invaluable therapeutic properties of this plant diversity, the current research has been conducted at 27 selected spots of four districts viz. Pithoragarh, Almora, Bageshwar, and Champawat of Uttarakhand state. A total number of 101 species of plants of medicinal values belonging to 48 families were recorded during the year of 2006-08. It was noted that the local people in the area under study are using some plant species widely to cure various diseases.

BIODIVERSITY, MEDICINAL PLANTS & AYURVEDA WITH REFERENCE TO DHAR BLOCK, DISTT GURDASPUR

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India is a mega diversity country with only 2.5% of land area of the world which further accounts for 7.8% of the global recorded species especially because of its varied physiography, diverse climatic conditions & a variety of habitats. The present paper discusses the variability among living organisms from all sources inter-alia terrestrial, marine and other aquatic ecosystems and all ecological complexes of which they are a part i.e biodiversity at ecosystem level, species level and within species. It discusses the importance of biodiversity, threats to biodiversity and our role in biodiversity conservation. The contribution of biodiversity to Ayurveda has also been elaborated. It is estimated that out of 45,000 plant species so far recorded by the Botanical survey of India, at least two thirds are medicinal. The article also examines the Rig veda, the oldest document available on medicinal plants to the modern medical scientist's views. The wholesome of drugs in Indian pharmacological theory is determined on the principle of dravyyaunavichara, i.e, the analysis of the nature and property of medicines on the basis of their elemental composition (dravya), quality (guna), taste (rasa), potency (virya), the after-taste following digestion (vipaka) and their specific actions (prabhva). The paper summarizes a survey conducted for the project "Study of local species of plant orgin of Dhar Kandi area of Punjab in relation to Medicinal & Economic Value". The emphasis of survey was to identify species available in the area and more than 180 species were identified on the basis of traditional study. Local plant species of medicinal value were identified during the survey and it was found that 100 common species were abundant and it was suggested to preserve them through proper knowledge. At the end, the paper recommends to preserve our medicinal plants and also suggests various biodiversity conservation methods like, awareness & capacity buiding programmes, with dove-tailing (i.e importance of biodiversity)of all projects , through legal measures, adopting adequate scientific measures for optimal balance between conservation and sustainable utilization practices, etc.

CLIMATE CHANGE AND AGRICULTURE & FOOD SECURITY

THE IMPACT OF CLIMATE CHANGE ON AGRICULTURAL BIODIVERSITY

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The agricultural biodiversity of Indian subcontinent is rich and unique, and has evolved over millions of years in response to diverse climatic conditions and farm practices. The recent researches indicate that it is vulnerable to current trends of climate change, particularly in combination with the demands of a growing population. The dynamics of agricultural biodiversity issues and climate change are directly linked. Agricultural biodiversity is at risk from climate change, particularly where it is accompanied by decreased annual rainfall and increased temperature, sea level rise, and increased frequency and severity of disturbances such as fire, drought, cyclones and floods. Species and communities at particular and possibly critical risk include those with limited climatic ranges and dispersal ability, and also those with specialized habitat requirements. For instance, plant species occurring at mountain and marine ecosystem are particularly vulnerable because they are highly adapted to particular ecological niches and have narrow habitat tolerances, thus unable to migrate because of lack of suitable habitats. The decrease in productivity of cereals, shift in altitudinal limits for temperate crops like apple, negative effect on milk production and reproductive functions particularly in cross breeds, reduction in freshwater fish biodiversity due to reduction in river discharge, cold water fish due to change in water temperature regimes are some of the notable impacts on agriculture. Pests outbreak pattern are suggested to change spatially and temporally e.g. bark beetles are normally restricted to lower levels of coniferous forests, but with an increase of temperature, coniferous populations are also threatened at high altitude areas. Further, the invasiveness of alien invasive species is likely in to increase and affect the distribution of native species.

The importance of agricultural biodiversity in food security and agriculture has been widely recognized with respect to its functions in climate change adaptation within the agriculture sector. Agro-ecosystem is characterized by high diversity at both the species and the gene levels and has much greater potential to adapt to climate change. It must become imperative to manage agro-biodiversity in a sustainable way and

to use it systematically to cope with the environmental challenges. Focused efforts for collection, conservation and evaluation in the light of expected temperature and moisture regimes to developed climate resilient and adaptive breeds and varieties are required. Gene sources from traditional varieties and breeds and wild types are to be tapped using techniques like allele mining and development of genomic resources for specific traits of interest for high temperature, photo insensitivity, low respiration and higher photosynthetic rate, drought, flood, salinity, pests etc. Species diversity reduces the probability of outbreaks of pests by diluting the availability of their host. On farm conservation would play crucial important role in addressing the issues of climate change. Storage of seeds in refrigerated banks or botanical gardens is essential but exposure to the environment, on farmers' fields and considering the wide agro-ecological variations of sites would be equally important. On-farm conservation is not necessarily less costly, but the costs are mainly borne by farmers whereas the benefits are private and public. Latest concepts of *in-situ* conservation follow the idea that conservation and use of genetic resources are closely linked. As long as farmers themselves find it in their own best interest to grow genetically diverse crops, both farmers and society as a whole will benefit at no extra cost to anyone and value has to be discovered in them. Therefore, formal institutional systems based on gene banks (*ex-situ* conservation) must be broadened to an integrated management system that includes the farmer based (*in-situ*) conservation. The aim of this paper is to review the current knowledge on the impact of climate change on agricultural biodiversity and its role in mitigating the impact of climate change and possible adaptation strategies using agricultural diversity.

AGRO-BIODIVERSITY, CLIMATE CHANGE AND FOOD SECURITY

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Any significant change in climatic conditions will affect the biodiversity and agriculture of a country. Even though some uncertainties persist about the nature and scope of the changes, there is recognition of the fact that shifts in agro climatic zones will mean that crops that have so far been cultivated in certain areas will no longer be adapted to those regions. One of the most important ways of coping with the impact of climate change on food security is to maintain the agro biodiversity of crop plants and their wild relatives. This agro biodiversity, once characterized, will serve as the gene pool that breeders can use to breed new varieties to support food security in a changing climate.

Gene Campaign has been setting up farmer level Gene-Seed Banks in Jharkhand, to conserve the genetic diversity of rice and other cereals, as well as vegetables, legumes and oilseeds. Some of these materials are in trials in research institutions like Indian Agricultural Research Institute, New Delhi and Birsa Agriculture University, Ranchi.

CLIMATE CHANGE AND FOOD SECURITY IN INDIA

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The projected increase of global mean temperature between 1.4 ^{0}C and 5.8^{0}C by 2100 (IPCC, 2007) is expected to have radical impacts on the hydrological system, sea level, ecosystems and crop production. Simulation studies of impact of climate change on wheat yields for several locations in India, indicated that in north India, a 1°C rise in mean temperature had no significant effect on potential yields, although an increase of 2°C reduced potential grain yields (15–17%) in most places. In the states of Jharkhand, Orissa, and Chhattisgarh alone, rice production losses due to severe droughts (about one year in five) average about 40% of total production.

In Rajasthan, a 2°C rise in temperature was estimated to reduce production of Pearl Millet by 10-15 % and if maximum and minimum temperature rise by 3°C and 3.5°C respectively, then Soybean yields in M. P. will decline by 5% compared to 1998. Simulation studies for looking at the impact of climate change on oil seed crops, projected the maximum decrease in grain yield of mustard (by 2.01 q per ha per degree rise in seasonal temperature) in Haryana, whilst a decline of 0.98 and 0.92 q per ha in grain yield was projected for UP and Rajasthan respectively. The oil sardine distribution has extended towards the northern latitudes and the catch has increased with increase in SST. The decline in fish stock as well as the fish distributions and abundances will affect positively or negatively the livelihoods of the Coastal-based harvesters. Moreover, agriculture will be worst affected in the coastal regions of Gujarat and Maharashtra, as fertile areas are vulnerable to inundation and salinisation. India will lose out in food production to countries like Russia, China, Canada and Argentina. This can be alarming with India where already per capita food grain is falling from 177 kg in 1991 to 155 kg in 2001. To reduce the vulnerability of food system to climate change and other global environmental changes, a multifaceted approach of adaptation in terms of increasing food production, improving food distribution and increasing economic access to food, as well as different mitigation options for reduction of green house gases, needs to be adopted.

AN ASSESSMENT OF ALTERNATIVE SCENARIOS OF CLIMATE CHANGE & ITS IMPACT AND OPPORTUNITIES IN FOOD SECURITY

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In this paper an attempt has been made to assess the different alternative situations of likely climate change, and its impact in the South Asian Region in general and in India in particular with respect to food security. While India has been generally food surplus country since the mid 1980s, the situation is changing in the last decade and India has to play a very crucial role for maintaining food security in the South Asian Region. Protection of environment and conservation of biodiversity has to be given due priority while maintaining food security for this highly populated region of the world. Food Security and price stability are of critical importance in the South Asian Region with significant rate of poverty and mal-nutrition which may affect the efforts in conservation of environment. In this paper an approach has been suggested to maintain food security in the region while taking into consideration conservation of biodiversity and protection of environment for sustainable development.

BANKING ON TRADITIONAL CROP VARIETIES FOR TACKLING CONCERNS OF FOOD SECURITY DUE TO CLIMATE VARIABILITY

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Serious decline in productivity of the agriculture produce has been portrayed due to climate change. The traditional crop varieties are possibly the immediate and cost effective options available with the local communities to tackle crop failures due to the climatic variations and to assure local food security. TERI is proposing value addition to develop the documentation of traditional crop varieties in the context of resilience to local climatic variation.

TERI facilitated revival of two traditional crop varieties in selected villages of Kalsi block of Dehradun district, Uttarakhand by community participation using community seed bank concept. The documentation of about 32 traditional crop varieties has been done to identify the important features of these varieties. The two minor millets namely *Chaini* and *Kauni* have been prioritized by discussing with local communities for revival. The seeds of these varieties have been shared with the interested farmers where after harvest the seeds would be returned back to the donors. The exchange mechanism facilitated by TERI has been successful in bringing back these two traditional crop varieties into cultivation to make them available locally.

To tackle the local climatic variation the database of characteristic of large number of traditional crop varieties is necessary. Such database can be developed and maintained in decentralized manner with the help of community based seed banks. The network of such decentralized seed banks could serve to exchange the suitable seed varieties from one region to another in the context of recent climatic variations in the local area. The mechanism could also be effectively utilized for *in-situ* conservation of germ plasm by involving the local communities. The initiative could provide a knowledge base for making agriculture resilient to climate change as emphasized by the National Action Plan on climate change.

LINKAGES BETWEEN ENVIRONMENT AND FOOD SECURITY IN NORTHERN ETHIOPIAN DRYLANDS

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This paper shall analyze the different rules and actors involved in linking environmental protection concerns with food security issues in Ethiopia and the existing perceptions about it. Mainstreaming food security issues into programs for biodiversity and land conservation poverty is a vital part of the CCD and the CBD. Programs focusing on poverty reduction and food security are also involved in environmental activities; examples include the World Food Programme, the UN Millennium Project and the Poverty reductions Strategies. Instruments of these programs show a broad and partly contradictory variety, varying from bottom-up to top-down approaches. Indigenous people and other locals may be involved, while at the same time experts and foreign NGO's may be involved. As a consequence, within the various international agreements, there exist synergies as well as trade-offs between environment and food security issues concerning their goals and also their processes of implementation. These are reflected accordingly by the implementing institutions from a national level down to the local level in Ethiopia. To analyse these, with the means of contingency and trade-off models, this paper intends to elaborate on the vertical and horizontal integration of the respective main international agreements and programs into Ethiopian national policies regarding environment and food security. Actors to be considered will be the major relevant stakeholders from responsible governmental and international organizations as well as farmers' organizations at the community level.

IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY AND FOOD SECURITY IN PALESTINE

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Global warming in the last century was fast enough that the resultant shifts in species ranges may have led to extensive biodiversity losses. The biodiversity of Historical Palestine (including the Occupied Palestinian Territories (OPT)) is considered one of the 25 recently-de? ned as "global biodiversity hot spots". The biodiversity in this region of the world is predominantly rich, as it is positioned at a cross-road between African, Asian and Mediterranean bio-geographic regions, each contributing to its different species. The speed and magnitude of climate change may elicit different responses at different levels of ecological organizations, namely the population, the species, and the community, as well as the whole ecosystem level. On the other hand, as a result of global warming, the agricultural sector in Palestine has been badly affected, particularly in the last two to three decades, which has been reflected on the food security. The climate change, added to the severe water shortages and the political instability in the region, has resulted in endangering or even loss of the biodiversity, and in the prices escalation of agricultural and other products. These consequences have certainly led to further instability in the Middle East, in general, and to the increase in poverty and unemployment levels in Palestine, in particular. It is important to mention here that the political actions taken by Israel against the Palestinian people and their lands, such as the confiscation of lands, on which Israel has illegally built the Segregation Wall and the hundreds of settlements, has badly deteriorated the environmental status, including the water shortages, which has directly affected the biodiversity and the food security in the Occupied Palestinian Territories. The predicted climate change will have many negative impacts on the OPT. These impacts would include increased scarcity of water resources, droughts, desertification, increased salinity of surface water and groundwater, greater frequency of sever climate events (such as heat waves, storms' intensity, rapid spread of diseases, etc.), and decrease in, and even loss of, biodiversity, as well as sea-level rise. All of these climate-change impacts have led and will also lead to, among many other consequences, agricultural reduction, crop failure, higher prices of products, and migration of population, known as "environmental migration", which will create "environmental refugees" who will be pushed inward to lands that are currently heavily populated.

CLIMATE CHANGE : DIRECT THREAT TO WHEAT PRODUCTION IN BANGLADESH

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Bangladesh is an agro-based, riverine and delta to the Bay of Bengal. It is located in South-east Asia and is a member of LDCS and heavily loaded with more than 150 million populations. The highest altitude is not more than 37 meter which covers only 15 percent and the rest of land is medium high to medium and leveled to sea-level. Most of the population stands below the poverty level and continuously struggles to search food security even for each day. Rice is staple food followed by wheat. But in last couple of years the hike of food price is burning issue of the poor. As a result, poor becomes poorer and poorer becomes poorest. Rapid change in climatic behavior due to global warming, deforestation, shifting of the agricultural land into infrastructures, high cropping intensity unknown disease and pest attack has marked a big question on the face of agricultural pattern finally to the food security of Bangladesh. From last few years the rivers have changed their normal path causing irregular floods and down warding of ground water table. Irregular duration of most expected Rabi (winter) season, irregular precipitation and reduction of rainfall has also thrown a big challenge to the agricultural system. From the scenario of last 30 years the highest water fall occurs in mid-June to July but in recent time it is in the month of August. No doubt, more than 4% of the total land area of Bangladesh will be a part of the Bay of Bengal if the melting rates of ice in the polar region remain unchanged in the next 50 years. Climatic change is directly threatening the world's first cereal i.e. wheat, which is second in Bangladesh. The decline in production of wheat has been discussed in this paper where the most efficient cultivars are now almost invalid due to the effect of global warming.

IMPACTS OF RISING TEMPERATURE AND CARBON DIOXIDE CONCENTRATION ON GROWTH AND YIELD OF CROPS

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Rising atmospheric CO_2 concentration and temperature are well documented climate change factors and can affect the phenological development processes and grain yield of various crops. Being the main substrate of photosynthesis, increasing CO_2 in the atmosphere may cause enhancement in photosynthesis and biomass production but CO_2 mediated increase in atmospheric temperature may offset its effect on crops productivity by shortening the grain filling period and growing season. Experiencing high temperature during flowering time may be more harmful and episodes of high temperature stress will be more frequent in a changing future climate scenario. We have quantified the effects of the magnitude and duration of high carbon dioxide and temperature exposure and their interaction on different crop genotype, on grain-set in more than 12 years of experiments with wheat, rice, chickpea, mungbean and sunflower. High CO_2 exposure caused appreciable increase in the yield of wheat and mungbean compared to control. High CO_2 grown wheat plants required application of super optimal dose of N fertilizers. It seems likely that the extent of the CO_2 fertilization effect will depend upon other factors such as irrigation and nutrient applications. In mungbean nodulation activity and root growth showed better response than shoot growth. There was significant increase in nitrogenase activity in high CO_2 grown mungbean plants. Similar effect of high CO_2 was recorded on plant dry weight grain yield of rice genotypes. But the CO_2 fertilization effect was leveled off by high temperature exposure of rice plants during flowering for duration of five days. These findings suggest that increased rate of crop growth at elevated atmospheric CO_2 concentrations may not counter the negative effect of increasing temperatures. We observed positive response of timely sown chickpea crop plants to higher temperature compared to late sown. These findings suggest that predicted increase in temperatures at the time of flowering can reduce the crop yield of some crops and simultaneous rise in atmospheric CO_2 will not counteracts these effects of temperature.

IMPACT OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTION IN INDIA

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World-wide, climate change and weather variability have become the topic of great concern in the recent years. It has likewise been accepted that climate change is largely caused by human activities and that the effects are inevitable, even if emissions of greenhouse gases (GHGs) are brought to an immediate end. There is an increasing concern that human activities may be inadvertently changing the climate of the globe through enhanced greenhouse effect, by past and continuing emissions of carbon dioxide and other green house gases which will cause the temperature of the earth surface to increase – popularly termed as global warming. The major cause to climate change has been ascribed to the increased levels of greenhouse gases due to the uncontrolled activities such as burning of fossil fuels, increased use of refrigerants and changed land use pattern related practices. There is a general consensus that greenhouse warming would have major impact on agro-ecosystems. The Fourth Assessment Report of Intergovernmental Panel on Climate Change, IPCC (2007) concluded that "there is high confidence that recent regional changes in temperature have had discernible impacts on many physical and biological systems". Recent IPCC report and a few other studies indicated a probability of 10-40% loss in crop production in India with increase in temperature by the end of this century due to global warming. Now it is beyond any doubt that the planet is warming and given the fact that during the last 50 years eleven of the twelve hottest years have been recorded after 1990, the magnitude of warming and risks associated with it may be even greater than predicted before. Increased concentration of greenhouse gases like CO_2 and warming will have serious consequences like rise in sea level, increased evaporation, increased frequency of extreme events like floods, droughts and heat waves. All these events will have profound impact on crop yields and farm profits particularly in tropical and sub tropical regions where abiotic stresses are already serious constraints to crop production. Increased temperatures will impact agricultural production. Higher temperatures reduce the total duration of a crop cycle by inducing early flowering, thus shortening the 'grain fill' period. The shorter the crop cycle, the lower the yield per unit area. It has been reported that wheat yield declined by 5% when temperature during

March increased above normal by 1^0 C under Punjab conditions. There was an increase of rice yield to the tune of 12% with the projected climate change scenario (increase of temperature by 1.5° C and rainfall by 2 mm at a CO_2 concentration of 460 ppm) in southern India. In Rajasthan, a 2° C rise in temperature was estimated to reduce production of pearl millet by 10-15 per cent. Studies conducted by IARI, New Delhi reported a loss of 4 to 5 million tones in the overall wheat production with every 1° C increase in temperature through out the growing period of the crop.

PROTECTION OF TRADITIONAL PLANT GENETIC RESOURCES

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The process of globalization has posed major challenges to developing countries on the issue of intellectual property protection. Developing countries maintain that it addresses problem of control over the market for technology. Advances in genomic studies and genetic engineering tools have placed enormous value on the information encoded in genetic resources. The CBD a multilaterally agreed framework has advanced beyond the conventional IPR to accept the sovereign rights of nations over their biodiversity resources and the need to share benefits with the local community. Inevitably this stand is in conflict with the patenting of live forms such as plant varieties. India has enacted a *sui generic* legislation on Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act 2001 in response to TRIPS regulation article 27.3(b) and Biological Diversity Act 2002, to safeguard the interests of breeders, farmers and traditional communities by considering WTO-TRIPS and our own interests. The Indian Patent law has made specific provisions for the disclosure of source of genetic resources and also the traditional knowledge for their use, if such genetic resources or traditional knowledge constitutes part of an invention. PPV&FR Act provides protection to newly bred, extant, farmers', essentially derived and transgenic varieties. For extant and farmers' varieties which are in public domain the DUS (Distinctiveness, uniformity, stability) features will be considered while the novelty (N) feature will not be taken because these varieties are not new and are in public domain. Had India followed patenting system for plant varieties, then extant and farmers varieties could not be protected by patenting system. For the registration of farmers' varieties, farmers have to be motivated for filing or the SAU's / ICAR institutes have to take the lead so that valuable germplasm can be protected. Pantnagar University has taken the lead in India by filing three applications of farmers' varieties of rice namely Tilakchandan, Hansraj and Indrasan on behalf of the farmers and for the benefit of farmers and is in the process of filing few more farmers' varieties in consultation with various SAU's and CS&Ts. However, registration of few varieties by one or two institutions will not help in protecting our valuable traditional genetic resources but concerted efforts are needed, so that no body can utilize the unprotected genetic resources for pecuniary gains.

IMPACT ASSESSMENT OF CLIMATIC CHANGE IN HIGHLY CULTIVATED TRACTS OF CENTRAL GANGA PLAIN

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The IPCC (Intergovernmental Panel on Climate Change) report on "effects of global warming by geographical regions" confirms change in agricultural yields and socio-economic turbulence thereafter. This lead the basis of our study targeting a part of Central Ganga Plain (CGP) which itself forms a part of vast Indo-Gangetic Plain. The CGP is considered as one of the highly cultivated region of the country. Agriculture is the main stay of life and over 70% of the population directly relies over it. The groundwater is the major source of domestic and agricultural uses. The CGP is environmentally sensitive to melting of glaciers and the occurrence of rainfall. The melting of glaciers in Himalayas feed and maintains the perennial flow of rivers like Ganga, Yamuna. The headword glaciers have either disappeared or are retreating at a faster rate thus causing unexpected floods in the foothills and at the same time affecting the water availability down stream during the summer or lean season in the long run. The rainfall over the CGP varies as much as 400 mm to 1200 mm. The occurrence of rainfall has become scanty and erratic through time. The monsoonal rainfall is characterized by groundwater recharges or rise in water table. Changes in the precipitation pattern will alter the flow pattern, discharge to the reservoirs and availability of water for agriculture, which is likely to create problems especially in arid and semi arid regions which are already facing water scarcity and are more sensitive to climatic variations. The unpredictability of monsoon encouraged the farmers to rely more on groundwater which has triggered the overexploitation. The overexploitation led to rise in electricity consumption which is needed to pump the groundwater. The energy-groundwater nexus can be looked as geo-environmental hazard as it deplete the groundwater and left the environment with more CO_2 contents.

The impact assessment of climate change on water resources can be best handled through simulation of the hydrological conditions that shall prevail under the projected weather conditions in an area. Thus, keeping this in view, the present study was subjected to numerical solution of

groundwater flows. The groundwater flow modeling included the development of mathematical model to simulate hydrogeological conditions of ground water flow systems in the area. A prediction scenario was made to predict aquifer response under variable rainfall recharge. The combined impact of increase in abstraction rate by 20% and reduction in rainfall by 20% were taken in to consideration as both the situations are acceptable in reality. The combined impact of both the factors shows that the maximum drawdown of 10 m is observed. The depleting groundwater resources have put a threat to sustainability of crop pattern especially to sugarcane, wheat and rice which require ample of water. The economy of the region is largely governed by sugarcane cropping. The deeper water level conditions left the shallow tubewell either completely dry or with insufficient yield. The installation of new tubewell to tap deeper water requires handsome investment which will be an additional burden to the society. The increased cost of tubewell installation in deeper levels will force poor farmers to purchase water from deep tube wells owners which fuel the informal water markets in the society. The low cost farming is to be affected at large which in turn, envisaged migration of poor farmer to other occupation for their livelihood.

SUSTAINABLE AGRICULTURAL DEVELOPMENT IN RAINFED SUBMONTANE REGION: THE CASE FOR A PARADIGM SHIFT IN LAND HUSBANDRY

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In order to tackle poverty and hunger in the rain fed submontane region, there is strong case for a focus on improving rain fed agricultural systems. There is utmost importance to deliver a transformation of agricultural productivity in such systems without adverse impacts on environmental goods and services. There is a growing advocacy on conservation agriculture (CA) as the desired approach and assess the evidence to support the assertion that it can deliver sustainable agricultural development in addition to following multiple livelihoods options. The case for paradigm shift hangs on the premise that conventional practice promotes land degradation, while the adoption of conservation agriculture practice delivers a range of benefits through promoting soil-ecosystem health. The one of the important approaches is to promote cultivation across the slope with improved variety of maize/wheat, application of farm yard manure @ 8-10 tons/ha, minor land shaping and adoption of soil conservation measures. In the area, the inputs applied by the farmers are low compared to the outputs obtained. Some evidences in the area suggest that conservation agriculture does not overcome constraints on low-external-input systems and will deliver the productivity gains that are required to achieve food security and poverty targets only if farmers have access to fertilizers, manures and quality seeds and availability of irrigation water to apply supplemental irrigations in winter months. It is also important to keep in mind the constraints of knowledge transfer and success will depend upon creating innovative networks, rural developments and income generating activities. It is further concluded that amongst small scale farmers partial adoption will be normal and it is not clear that this will deliver soil health benefits claimed for full adoption of the new paradigm.

FUTURE RESEARCH ISSUES FOR SUSTAINABILITY OF PUNJAB AGRICULTURE

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The green revolution in seventies enhanced agricultural production in the state beyond expectation. The state has rightly earned the name of 'food basket of India.' The remarkable agricultural production in the state has come with a cost, the consequences of which are being faced now. In a bid to produce more, Punjab has overexploited its natural resources. Therefore, present day Punjab agriculture is passing through critical phase. Potential threats to sustainability of Punjab agriculture are depleting water table, deterioration of soil, resistance of insects/pests to insecticides and pesticides, resistance of weeds to weedicides, excessive use of agro-chemicals, stagnation in productivity, escalating input prices, mismanagement of crop residues, erosion of bio-diversity, fertile land being taken away by urbanization and industrialization, decreasing farm size, owning excessive farm machinery, reluctance of youth from farm work, climatic changes, lowering public investment in agriculture, increasing air pollution etc. The state cannot afford to rest on its past laurels. It is time to take up these challenges so that the Punjab agriculture continues to be vibrant and at the forefront of Indian agriculture.

To address these potential threats the specific research issues to be taken up should include; production of transgenic crops and application of newer tools of genetic engineering to break yield barriers, recycling of crop residues, strengthening the technologies for efficient post harvest management and agro-processing for value addition, developing technology for other alternatives for enhanced income, participatory research with involvement of farmers and end users like industry to develop commercially acceptable technologies, continuing farm machinery development for precision agriculture technology generation for ground water recharging and other water conservation technologies, emphasis on efficient management of natural resources by the application of remote sensing techniques (RS), IT-based decision support systems for technology transfer and market surveillance.

CROP CYCLE MANAGEMENT : ADAPTATION TO CLIMATE CHANGE EFFECTS IN FLOOD AFFECTED AREAS OF EASTERN U.P.

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Eastern Uttar Pradesh is among the most naturally bountiful regions in the country, with plentiful availability of underground and surface water. But large parts of the region are also poverty-stricken and flood affected. In a region where agriculture on small land holding is predominant, floods have caused extreme devastations. Though, floods are natural phenomenon in the region, it is only that over the last decades-due to climate change- patterns, character, duration and extent of floods have changed and cause misery to the people. The impacts are evident primarily on agriculture.

However, farmers are generally adapting to such climate change effects which is helping them to mitigate the losses. The major strategies adopted in such measures are intensification, diversification, value addition, use of indigenous technical knowledge, market linkages and collective actions.

The management of cropping cycle has helped the farmers. Selection of locally appropriate varieties and other agro-ecological measures have helped the small farmers in dealing with climate change impacts in form of floods.

In the study, such practices have been documented. The crop management measures can be divided into following three groups :

- Pre-ponement of crops : to harvest the crops before flooding period.
- Water withstanding crops : to sustain floods and water logging situations.
- Post-ponement of crops : late sowing, after the flooding period is over.

The practices generally innovated by farmers are time tested and effective.

GLOBAL WARMING AND CROP PRODUCTIVITY

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Global warming has often been described as one of the most serious environmental problems ever to confront humanity as this problem is closely linked to the process of development and economic growth itself. Global warming is the increase in global mean temperature of earth due to build up of atmospheric green house gases because of continuous increase in temperature. Global warming is when the earth heats up or the temperature rises. It happens when green house gases (CO_2, CH_4, N_2O and water vapour) trap heat and lights from the sun in the earth's atmosphere, which increases the temperature. Presently, global warming, extinction of biodiversity, worldwide food shortages and spiraling food grain prices have resurrected the specter of a hungry world, roiled with unrest and political upheavals. Several theories have also been brought out of the closest to explain, or rationalize, this haunting vision. Climate change will have several implications, as numerous adverse impacts are expected for some populations in terms of access to clean water, access to sufficient food, stable health conditions, ecosystem resources, security of settlements. Before the industrial revolution, climate change was a gradual process but in the recent past, the rate of change has been triggered due to tremendous increase in pollution, found to be a consequence of industrialization. Human-made green house gases (CH_4, O_3, CO_2, N_2O, H_2O and CFCs) have caused the largest change in climate forcings in recent centuries. These gases absorb the Earth's infrared (heat) radiation. The temperature of the earth is regulated by the green house effect. Global warming is also known as green house effect.

The chief green house gases are water vapour, CO_2, CH_4, nitrous oxide and various complex human-made compounds. They are entirely responsible for reflecting downward heat that the Earth's surface would otherwise seed into space. The gases that make rest of the atmosphere, nitrogen (78%), oxygen (21%) and Argan (0.9%) are transparent to heat as well as to light and contribute nothing to the green house effect. Without this

effect, the Earth's surface on an average would be 33 degrees Celsius colder, yielding an ice-covered planet inhospitable to life as we know it. Having some green house gases in the air, thus, makes life possible. But if their concentrations exceed critical levels, conditions could become less favourable for human beings and other species, carbon dioxide (CO_2) gas generated by man's burning of fossil fuels and the forests is responsible for about half the green house gas warming. Other gases (CFCs, nitrous oxide, methane, ozone) are responsible for the rest. Increases in all these gases are due to mankind's explosive population growth over the last century, and increased industrial expansion. Approximately 80% of atmospheric CO_2 increases are due to man's use of fossil fuels: oil, coal and gas. While the pattern of future warming is very much open to debate, it is indisputable that the surface of the earth has warmed, on an average, 0.3 to 0.6 °C since the late 19th century. The ten warmest years in the last 130 years, have all occurred in the 1980s, and 1990s. and within this ten years the three warmest years were in 1990s.

It is considered that till mid of 21st Century mean temperature could have risen by 1-3 °C (2-5 F°), and sea will rise by 0.6 m (2 ft) for every 1 °C increase in temperature due to thermal expansion. It will rise further because of the partial melting of mountain glaciers and polar ice sheets. Unless they are protected, places like Amsterdam, Mumbai, Hong Kong, Los Angeles, New York, Tokyo and Sydney could disappear under a 3 m (10 ft) rise in sea level by the year 2100. Global warming will upset normal weather cycles, which will most likely lead to outbreaks of hantavirus as well as malaria, dengue and yellow fevers, filariasis, encephalitis sehistosomiaris and cholera. Scientists are convinced that human actions are causing global warming, if this is so, it stands to reason that our own actions can also help to reduce this threat.

IMPACT OF GLOBAL WARMING ON FRUIT INDUSTRY – A REVIEW

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Global warming has increased temperature by 0.74 °C ± 0.18 °C over the last hundered years. The rate of warming over the last fifty years is almost doubled that of the rate over the last hundred years. The period from 1995 to 2007 rank among the 12 warmest years on record since 1850 (IPCC, 2007). Changes in extremes of temperature are also consistent with warming of climate which will impact food crops around the world due to effects on plant growth and yield by higher temperatures, elevated CO_2, altered precipitation and transpiration regimes and increased frequency of extreme events, as well as modified weed, pest and pathogen pressure. It is reviewed from the literature that the production as well as quality of fruits are highly affected by this change. Rising temperature significantly reduces the chill hours needed for fruit and nut tree development that lead to unfruitfulness in many varieties. If such rise in temperature remained continue, some high-value fruit crops such as almonds, cherries and apricots may no longer be able to produce. In Japanese pear effect of high temperature on bud dormancy was observed and mitigated by hydrogen per oxide treatment. Temperature is one of the most important and controlling factors in wine grape development. Unchecked global warming is expected to impair wine grape growing throughout the central valley in California. High temperature affects the quality of fruits especially in apples, grapes by impairing the colour development. Increased summer temperature increases transpiration and water needs leading to higher summer rainfall that affects the sweat cherries cracking and increases disease pressure. Warmer late fall temperature will delay onset of winter acclimation, reduce cold hardiness and winter injury to wine grapes, peaches and sweat cherries. Due to warmer springs flower buds become susceptible to colder injury early in the spring. Forth assessment report of IPCC projected warming of about 0.2 °C per decade for next two decades. So there is need to meet the challenges of global warming to fruit industry by introducing new fruit crops, developing new varieties and production technologies for climatic adoption of fruit crops.

TRANSGENIC CROPS - EFFECT ON BIODIVERSITY

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Transgenic or genetically modified plants possess novel genes that impart desirable characteristics such as resistance to insect, pest, herbicide and other stressful conditions like drought, salinity, or water logging. These crops hold great promise in evolving more productivity and sustainable agriculture in the coming years. Among transgenic, Bt crops are increasingly becoming a large part of modern agriculture and are grown in many countries like Australia, South Africa, India, Mexico, Spain, Portugal, Romania, Ukraine, USA, China, etc.. With tremendous increase in the adoption of these crops, there is great concern among scientists, policy makers, regulatory agencies and the public about their potential ecological impact. Despite their proven safety and benefits, there has been an unending debate on the safety and benefits of transgenic crops. As we celebrate the 10th anniversary of the large scale commercial cultivation of transgenic crops in multiple countries, there are still some serious concerns that need to be addressed carefully including development of 'super weeds', contamination of non transgenic plants, threat to other organisms in the environment, health hazards, bio safety and effect on biodiversity.

SEED STORAGE FOR FOOD SECURITY

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Seed deterioration is a major problem in agricultural production. The purpose of seed storage is to preserve planting stocks from one season to the next and long term storage in gene banks for maintenance of germ plasm. This creates a greater diversity in seed inventory and provides a guarantee of seed supply in the years when acceptable seed quality and production is low. Seeds being viable undergo aging in stores due to changes in metabolic activities, physiological, biochemical, microbial and environmental factors which include storage temperature, relative humidity, oxygen, physical conditions of the seed, initial seed quality, seed moisture, duration of storage, genetic factors (kind/variety of the seed), and structure of seed. Worldwide, significant losses occur due to poor seed quality particularly in areas where high temperature and humid conditions prevail during seed maturation and storage. Life of the seed can be prolonged by providing better storage conditions from the time they are harvested until the time they are planted. To maintain the seed viability or seed germination and vigour above minimum seed certification standards (MSCS), seeds should be stored scientifically. The storage environment should follow Harrington's thumb rule, according to which the sum of temperature in °F and atmospheric relative humidity in percent should not exceed 100. Most crop seeds lose their viability at relative humidities approaching 80% and temperatures of 25-30°C but can be kept for 10 years longer at relative humidity of 50% or less and a temperature of 5-15°C.

ORGANIC FARMING AS A WINDOW TO FOOD SECURITY-A CASE STUDY OF PUNJAB

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Global climate change has posed serious threats to mankind and severe amongst these is food security. As reported in IPCC, moisture stress from prolonged dry spells, thermal stress from heat wave during critical life stage of crops and water stress along with elevated CO_2 levels are the major stresses which have been identified to food security. Acute water shortages in combination with thermal stress has got potential to adversely affect the wheat production but more severely affected will be rice productivity even under positive effects of elevated CO_2 levels in future. Thermal stress as a result of higher temperatures will also induce high incidence of pest outbreaks and reduce host resistance against these pests. In the past few years food grain production has stagnated on account of depleted soil nutrients, indiscriminate use of pesticides and fertilizers along with fall in groundwater table and has put a question mark on sustainability of agriculture practices. Looking at above challenges a group of 200 farmers initiated practicing organic farming in Nabha Block of Punjab state. Their experiences reveal that water stress can be reduced considerably as their number of irrigations was less when compared with chemical farming. Soil fertility enhanced as organic carbon and essential micronutrients level got increased in the soil. Cost benefit analysis put farmers in a position where their income was higher as their input cost declined because of no use of chemical pesticides and fertilizers. Damage to their standing crop was very less due to hailstorms, heavy rains and pest attack.

MITIGATING CLIMATE CHANGE: POLICY ISSUES FOR PROMOTING ORGANIC FARMING

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The FAO has already estimated that organic agriculture is likely to emit less nitrous oxide. This is due to lower N inputs, less N from organic manure from lower livestock densities; higher C/N ratios of applied organic manure giving less readily available mineral N in the soil as a source of denitrification; and efficient uptake of mobile N in soils by using cover crops. Greenhouse gas emissions were calculated to be 48-66 percent lower per hectare in organic farming systems in Europe, and were attributed to no input of chemical N fertilizers, less use of high energy consuming feedstuffs, low input of P, K mineral fertilizers, and elimination of pesticides, as characteristic of organic agriculture.Many experiments have found reduced leaching of nitrates from organic soils into ground and surface waters, which are a major source of nitrous oxide.

The interest in organic agriculture in developing countries is growing because it places more reliance on the natural and human resources available, requires less financial input and provides safe food while conserving the environment. Studies to date seem to indicate that organic agriculture offers comparative advantage in areas with less rainfall and relatively low natural and soil fertility levels. Labour realizes a good return and this is important where paid labour is almost non-existent. Organic agriculture does not need costly investments in irrigation, energy and external inputs, but rather organic agricultural policies have the potential to improve local food security, especially in marginal areas.

The paper attempts to suggest policy issues for consideration of Planners focusing on conversion of land area and market-driven products, extend support for certification, promote local certifying bodies; development of agronomic practices; extension support and training to farmers while creating awareness to consumers; paradigm shift from quantity to quality and thereby increasing farmers income instead of yield.

MUSTARD SEED PRIMING : A STEP TOWARDS ADVACING NITRATE NITROGEN HARVESTING AND STRESS TOLERANCE FOR AGRICULTURAL SUSTAINABLITY AND FOOD SECURITY IN MODERN ERA

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The primed ($Mg(NO_3)_2$, Salicylic acid and $Mg(NO_3)_2$ + Salicylic acid) and non-Primed (control) seeds of Mustard (*Brassica juncea* L. *Czern and coss*.) cultivars Kranti and Varuna were evaluated for nitrogen harvesting and abiotic stress tolerance coming during plants life in field in late sowing condition in this crop. The objectives of the study were to determine the factors responsible for nitrogen harvesting and stress ameliorating characters (a) as well as to optimize the best seed quality enhancement criteria for advancing both of them (b) and also to improve nitrogen utilizing criteria of crop from excess application of nitrogen fertilizer in the field (c). The plants emerged from primed seeds were assessed for nitrate reductase (NR) activity membrane injury (MI), proline and chlorophyll contents in leaves and nitrogen content in different plant parts. Osmohardening/ osmopriming treatments showed significant improvement in chlorophyll and NR activity that helped in accumulation of nitrogen in seed and plant which was supported by decreased leakiness of electrolytes and enhanced proline content. Increment in nitrogen accumulation by only seed priming with $Mg(NO_3)_2$, Salicylic acid and their combination revealed that treated plants had capacity to absorb more soil nitrogen in comparison to non-treated one thereby reducing residual nitrate nitrogen in soil in timely as well as in late sown condition. Hence, it may minimize nitrate pollution in soil indirectly. The work may open a channel not only for agricultural sustainability and food security for various field crops but may also provide improved livelihood through enhancing the socio-economic condition of the farmers by means of on farm training of this seed priming technology which is very economical one. The work will also be discussed on the basis of seed priming and its relation to climate change.

VEGETABLE CROPS FOR FOOD, NUTRITION SECURITY AND IMPROVING LIVELIHOOD

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The global food crisis is afflicting the whole world - developed, developing and underdeveloped. Vegetables play an important role in diversification, employment generation, food, nutrition security and improving livelihood. Cereal based cropping system is ineffective, when compared with vegetable crops for providing food and nutrition security as the productivity of major vegetables are at least 3-4 times more than the major cereal crops and they are rich in nutrient content also. The productivity of rice, wheat, and maize are 22.5 tons/ha, 38.95 tons/ha and 26.98 tons/ha, respectively, while the productivity of potato, tomato, sweet potato 198 tons/ha, 156 tons/ha and 83 tons/ha, respectively. For proper well being, an adult of moderate work style require 2500 kcal and consumption of 300g vegetables comprising 125 g leafy vegetables, 100g root and tuber vegetables and 75 g other vegetables have been recommended by ICMR and NII, Hyderabad. Besides food security, nutritional security is a major concern. A global survey report estimates that more than 200 million children in developing countries suffer from malnutrition. Leafy vegetables are rich reservoir of vitamins and minerals, root and tuberous vegetables are good source of carbohydrate and leguminous vegetables are good source of protein. Vegetables being labour intensive generate lot of employment opportunity. The profit from vegetables by way of fresh sale, processed product sell, export and seed business is quite higher than other crops. Besides this, vegetables contain a large number of non nutritive pytochemicals, which help in prevention of many deadly diseases. The prominent protective vegetables are bitter gourd, bottle gourd, garlic, onion, tomato, etc. So in the era of rapid global climate change, increased industrialization and urbanization and decreased input use efficiency, vegetable crops are the safe option for diversification of our cereal based cropping system to ensure food, nutrition and livelihood security.

CHARACTERIZATION OF HYDRO-THERMALLY TREATED BUCKWHEAT (*FAGOPYRUM ESCULENTUM*) STARCHES

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Buckwheat (*Fagopyrum esculentum*) an ancient plant is neither a nut nor a cereal like wheat, but rather a pseudo cereal. Buckwheat has gained an excellent reputation for its nutritious qualities in the human diet. Its renewed popularity stems from its many bioactive components, which have been shown to provide various health benefits. It is the very versatility and multi-functionality of starch, which have made it an indispensable tool in creating innovative foods for the future. Buckwheat starches or their derivates can be used in various foods such as dairy desserts, fruit preparations and baked snacks to baby food, meat products and pasta as major ingredients or as an additive to optimize processing efficiency, product quality or shelf- life. The present investigation was undertaken to characterize buckwheat starches modified by hydrothermal treatment. Increase in amylose content (25.7%) in hydrothermally treated starches may be due to additional interaction between amylose-amylose and amylopectin–amylopectin chains. The oil and water binding capacity has increased by 167.42% and 152.74% respectively. Sediment volume, solubility and swelling power was declined with hydrothermal modification. Pasting temperature slightly increased with the levels of moisture treatment to 94.75 ^{0}C. Peak viscosity of hydrothermal modified starch is 2102 cP. Breakdown and set-back values were significantly reduced after hydrothermal modification to 20cP and 99 cP, respectively.

CALCIUM INDUCED THERMOTOLERANCE IN RELATION TO CARBOHYDRATE METABOLISM IN WHEAT SEEDLING

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Germinating seedlings of three wheat cultivars (cvs) viz. PBW 343, C 306 (heat tolerant) and WH 542 (heat susceptible) with a radicle length 5 mm, were subjected to a brief heat shock episode of 45°C followed by transfer to the normal temperature (25°C) for three days in dark, with and without Ca^{2+} (5 mM), in order to ascertain role of Ca^{2+} in modulating the heat shock response of etiolated seedlings. Heat shock treatment resulted in decline in activities of soluble acid invertase as well as starch mobilizing enzymes and, thereby, seedling growth. This effect was more pronounced in susceptible cv as compared to tolerant cvs. However, enhancement in total sugar content with heat shock was higher in tolerant cv than susceptible cvs. With Ca^{2+} pretreatment, a substantial increase in total sugars and reducing sugars as well as activities of both, and amylases was observed in both control and stressed seedlings. Subsequently, at normal temperature Ca^{2+} had no significant effect on seedling growth and acid invertase activity, whereas, under stress conditions it improved the shoot and root length with enhancement in acid invertase activity. Thus, an appreciable level of thermo protection was induced with 5 mM Ca^{2+} under stress conditions indicating that Ca^{2+} level required for growth under heat stress exceeds that required for growth under normal conditions. Elevated Ca^{2+} concentration may alleviate the inhibition of sucrose and starch metabolism, thereby, increasing their utilization for seedling growth under heat stress.

OKRA CULTIVATION IN WINTER SEASON : SOME CONSIDERATIONS

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Okra, an important vegetable crop, is mainly grown in summer and rainy seasons in India. Its cultivation during the winter season under open field conditions is not possible especially in the Punjab state where temperature during December and January is very low. However, if okra cultivation is undertaken during the winter season, it would not only make okra available to the consumers from February to April, but also bring premium to the growers. Accordingly, a factorial experiment was planned to study factors affecting yield of okra under poly house conditions during winter season. The main plot treatments consisted of three dates of sowing (November 20, December 4 and December 20, 2007); sub plot treatments being three plant to plant spacings (10, 15 and 20 cm) and three okra varieties (Punjab 7, Punjab 8 and Pusa Padmini). Analysis of variance revealed significant differences among all the factors studied. Maximum yield was obtained when planting was done on December 20, though it was statistically at par when sowing was accomplished on December 4. Spacing of plants at 20 cm and Punjab 8 among the varieties were found to be better. Significant interactions of date of sowing x varieties, spacing x varieties, and date of sowing x varieties x spacing were observed. The preliminary results indicate that it may be rewarding to exploit these interactions to obtain acceptable fruit yields of okra grown in the off-season under poly house conditions.

ECONOMIC CHALLENGES AND CLIMATE CHANGE

ECONOMICS AND CLIMATE CHANGE

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Concern has grown in recent years over the issue of global climate change and the cost of adaptation and mitigation. Scientists have projected doubling of accumulated carbon dioxide in the Earth's atmosphere and predicted Loss of land, species and forest, disruption of water supplies to cities and agriculture, Health damage and deaths from heat waves and spread of tropical diseases and Loss of agricultural output due to drought. In addition to these effects, there are some other, less predictable but possibly more damaging effects such as disruption of weather patterns, with increased frequency of hurricanes and other extreme weather events, sudden major climate changes, like climate change of Europe to that of Alaska and increased release of carbon dioxide from warming arctic tundra, which would speed up global warming.

Global economic approaches suggested are cost-benefit analysis and /or cost-effectiveness analysis. While Cost-benefit analysis attempts to decide whether or not a policy should be implemented, cost-effectiveness analysis considers the most efficient way to reach a policy goal. In general, economists favor approaches that work through market mechanisms. Even with the best data currently available, the actual effects of climate change cannot be precisely determined. The uncertainties make the economic analyses of global climate change very difficult.

The current government expenditure in India on adaptation to climate variability, exceeds 2.6% of the GDP. As per the National Action Plan on Climate Change to name a few, significant investment costs are associated with energy efficient technologies for lightening which is to be integrated with housing finance schemes, incentivizing equipment purchase and utility based Programmes. Special financing mechanisms; such as bundling and/or programmatic CDM are being thought of for enhanced energy efficiency in SME's and increase in the outlay of JNNURM for water supply and Sewerage. It is accepted that economic - mitigation is costly and could threaten India 's economic growth.

ECONOMIC IMPACT OF CLIMATE CHANGE ON ISRAELI AGRICULTURE

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Climate changes, followed by accumulation of green house gases, are expected to have a profound influence on Agriculture sustainability in Israel, a semi-arid area characterized by a cold wet winter and a dry warm summer. The intention of this study is to explore economic aspects associated with Agriculture production under projected climate-change scenario. To this end we apply methodology known as the "production functions" approach to two representative crops: wheat, as the major crop in Israel's dry southern region and cotton, representing the more humid climate at the north of the country.

Adjusting outputs of the global climate model had CM3 to the specific reproach locations. We generated projections for 2070–2100 temperatures and precipitations for two climate scenarios; net revenues become negative under severe scenario, but may increase under the moderate one depending on nitrogen applied to the crop. Distribution of rain events was found to play a major role in yield production. By contrast, under both scenarios cotton evinces a considerable decrease in yield, resulting in significant economic losses. Additional irrigation and nitrogen may reduce farming losses, unlike changes in seeding date.

CLIMATE CHANGE AND THE COASTAL VULNERABILITIES IN KUTUBDIA - AN OFFSHORE ISLAND OF BANGLADESH

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Global climate change is now a reality and the change is mainly happening due to global warming. The coastal area in Bangladesh represents an area of 47,211 km^2 (32% of the country's geographical area) with a population of 35 million (28% of the total population) distributed in 19 districts. Bangladesh is facing serious consequences of biodiversity loss from the effects of climate change and sea level rise particularly in the coastal areas of the country. Though factual information regarding the extent of sea level rise in Bangladesh is scarce but estimation is that Bangladesh has warmed up by about 0.5°C and 0.5m rise of sea level in the Bay of Bengal over a period of last 100 years. Sea level rise threatens to inundate low-lying area and off-shore islands of the country, increasing salinity and disappearance of many native varieties of crops. Kutubdia, an offshore island of Bangladesh with an original area of 251 km^2 are reached to <52 km^2 with a population of 1,15,000 are facing the global climate change effects, particularly the tropical cyclonic storms and the loss of biodiversity and their negative impacts on the livelihoods. The paper describes the status of Kutubdia Island with a review of previous tropical cyclones, storms and their devastating effects on the socio-economy of the islanders. The 1991cyclone alone killed more than 10,000 people and damaged most of the houses of this beautiful island. Global climate change projection estimates that the island will be eroded completely within next 40 years and anticipated sea level rise is likely to destroy most of the existing coastal areas of the country, if preventive measures are not taken with global integrated efforts. Future impacts of climate change will worsen the vulnerabilities not of this island, but also all along 716 km coastal areas of the country. Recommendations put forward for understanding the climate change, its causes and consequences and appropriate mitigation measures for an off-shore island- Kutubdia of Bangladesh.

MATHEMATICAL MODELS BASED ON CLIMATIC FACTORS FOR ESTIMATING INFLUENCE OF CLIMATIC CHANGE ON THE CROP PRODUCTION

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Climate changes play important role in year- to- year variability in crop production, even in high yield and high technology environments. Crop performance during different seasons allow the scientists to take account of the effect of climate change on growth, development and yield. The most important climatic factors that influence growth and development by altering the physiological process are air temperature, solar radiation, rainfall and wind. Much of our knowledge of future climatic changes comes from the studies using the mathematical models. Statistical relationships between crop yield and main climatic factors are vital and can be used for developing forecasting model. Some models (Viz: Crop growth models, Crop phenology models, Yield forecasting models, Disease/ Insect-pest forecasting models) are developed based on regression technique and other statistical techniques to analyze two or more stress factors with an assumption that all other factors which influence crop growth are optimum. Prediction about the climatic factors and crop production is urgently required to make the future policy for food security. In this paper, we discussed the application of different mathematical models based on climatic factors for future forecasting.

GREEN ENTREPRENEURSHIP FOR SUSTAINABILITY

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Climate change is likely to have a much greater impact on India than other countries in similar positions (UNIDO). Extra impact on India is due to unique combination of its geography, diverse population characteristics, and extremely high dependability on fossil fuels. By 2100, increased emissions of CO_2, methane and aerosols will have forcing pressure on the climate system. The catchword for the draft of Indian national action plan is "saving" or "efficiency" (avoidance of emissions) rather than capping (Climate Change, Greening India, Draft June 4, 2008). The present paper is an attempt to bring forth strategies and opportunities for green entrepreneurship which is setting up of small and medium business enterprises that are environment friendly and sustainable development oriented.

Main objective of this paper is to bring forth opportunities for ecopreneurs. Data to achieve these objectives has been collected from various sources like Net, journals, newspapers and magazines. Green, sustainability, philanthropic, environmental, clean, natural, healthy, organic, conscious – capitalism, and ethical – consumerism are explained. All these words define the movement of both consumers and companies to become socially responsible for their actions and their products or services – the very heart of the business is changing. Making a profit and striving for a healthier planet with healthier people are now bundled together.

Inc. magazine reported : "…something seems different about our current green awakening". Entrepreneurs in India must incorporate greenness into their work. The trends are : (i) customers are increasingly aware of environmental issues; (ii) customers are increasingly drawn to green businesses; (iii) governments are forcing green issues; (iv) personal and professional investors are going green; (v) green business infrastructure is growing. The best five opportunities areas are : (1) Organic products; (2) Trash; (3) Governments; (4) Green life-style; and (5) Local angle. There are also green opportunities for existing businesses. *Harvard Business Review*

called these co-shared values and asked whether the business creates a meaningful benefit for society that is also valuable to the business. The other thing small business owners should keep in mind is that they need to tell people about their green efforts. The paper concludes by emphasizing the points : (1) Business Goes from Zero to Hero; (2) Alt-Fuel Vehicles Get in Gear; (3) Carbon Neutral Brings Hope and Hype; (4) Financial Sector Takes on Climate; (5) Investors Flex Their Muscle on Climate; (6) Renewables Become the New Recycled; (7) Water Rises as a Business Issue and Opportunity; (8) Computer Industry Plugs into Green; (9) Green Chemicals Become Supercritical; and (10) Green Becomes an Engine of Growth.

Will sustainability truly become an engine for business opportunity and growth in India ?

CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT ISSUES

CLIMATE CHANGE – PERCEPTIONS ON REASONS, EFFECTS & CORRECTIVE MEASURES

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Of the two most famous Global Conventions –'Biodiversity' and 'Climate Change', the latter has invited grave concern because of relatively too soon effects. Global warming is the greatest concern of the environmentalists and the scientists around the globe. What shall be left if the whole snow of Mount Everest, the highest peak of the world, melts? Industrial development, has undoubtedly contributed towards the economic growth, employment generation and the comfortable living but associated with industrialization and fast urbanization, are the environmental problems like industrial pollution, vanishing forest cover, burning of fossil fuels etc. which are chiefly responsible for rising temperatures. Emission of Green House Gases such as carbon dioxide, methane, nitrous oxide as well as manufactured gases like chlorofluorocarbons or their substitutes have changed the chemical composition of the atmosphere and are instrumental in the Ozone layer depletion. Ozone layer prevents the harmful gases and ultra-violet rays from entering the earth's atmosphere and thus helps in reducing the Global Warming. India ranks 4th among the top 10 emitters of carbon dioxide. It is important to curb green house gases otherwise the higher temperatures can drive plants and animals to extinction, and accelerate the rate of climate change. The snow covering the Northern Hemisphere and the floating ice in the Arctic Ocean have decreased over the past century. By the efficient use of the appliances, using incandescent light bulbs, efficient cooking methods, composting the waste, car pool or walking short distances, sparing use of refrigerators can reduce energy consumption at individual level and thus check the earth warming. It demands effective strong corrective measures, instead of cosmetic attempts just to gain political mileage. It is proposed to discuss the possible measures at the individual, local, national and global level to curb the increasing temperatures to the levels as per the Kyoto Protocol.

CLIMATE CHANGE AND NUCLEAR ENERGY : RADIOACTIVE WASTE MANAGEMENT PRACTICES IN INDIA

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Presently, at various sites in India, there are 17 nuclear power units in operation, 2 units under commissioning and 4 units under construction. In the near future, more nuclear power units and associated facilities are likely to be set up in view of the demand for electricity in the country. The safe and effective management of radioactive waste generated during production of electricity from nuclear power plants has been given utmost importance from the very inception of nuclear industry in India. Radioactive waste is generated at various stages of the nuclear fuel cycle e.g. reactor operation and spent nuclear fuel reprocessing. Volume of waste per unit of energy produced is, however, very small in case of nuclear power. Besides these sources, radioactive waste is also produced as a result of the ever-increasing use of radioisotopes in research, health care and industry.

The underlying objective that governs the management of radioactive waste is protection of human being and environment, now as well as in future. This paper outlines the national framework, basic philosophy, R&D, processes & technology for treatment and methodology for disposal of various types of radioactive waste.

CLIMATE CHANGE FROM THE PERSPECTIVE OF A NUCLEAR SCIENTIST

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The phenomenon of global warming which is supposed to be bringing drastic changes in the climate has become a debatable issue. One group of scientists feel that the increase in global temperature resulting from increase in the concentration of anthropogenic green house gases is going to become more serious in the coming years. There is, however, another group which feels that the hullabaloo of global warming is exaggerated and requires to be seen from different frame of reference.

In the present talk the issue of global warming will be discussed from the lessons gained from the work carried out on the nuclear winter phenomenon which had become a talked about issue in the eighties.

The concept of nuclear winter was proposed in early eighties by R.P. Turco, O.B. Toon, T.P. Ackerman, J.B. Pollock and Carl Sagan. It was predicted that large scale detonation of nuclear weapons would result in the change of the climatic pattern of the earth as a result of setting in of a severe cold condition for extended period of time. The concept was based on the idea that large scale dust and ash thrown in the atmosphere will lead to blocking of sunlight resulting in the drop of temperature, a phenomenon similar to the cooling effects observed on Mars caused by dust storms. The initial model has been modified from time to time and the new results show that the severity predicted in the earlier model requires to be toned down. However, the time period of nuclear winter has to be extended.

The presentation will be discussing further the past and present perceptions about nuclear winter by experts around the world taking into account the knowledge gained in recent years from oil well fires of Kuwait, the effects of natural volcanic eruptions besides the observations made by experts on paleoclimatology.

RESPONDING TO THE CHALLENGES OF CLIMATE CHANGE : MOUNTAIN SPECIFIC ISSUES

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Climate change (CC) is the single biggest challenge facing our planet today. Scientific reports indicate that global average air temperature near the earth's surface rose 0.74 ± 0.18 oC during the 20th century. Climate models referenced by the IPCC project that global surface temperatures are likely to increase by 1.1 to 6.4 °C between 1990 and 2100. The present atmospheric conc. of CO^2 is about 383 ppm by volume and future rise in CO^2 levels are expected to rise from 541 to 970 ppm by the year 2100 due to ongoing burning of fossil fuels and land use change. The IPCC concludes, "most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas (GHGs) concentrations" via the greenhouse effect.

The Himalayan mountains are particularly susceptible to impacts of CC because of their young and fragile nature coupled with sharp bio-physical gradients. Due to differences in altitude, latitude and longitude and a variety of microhabitats these mountains are home to several species of flora and fauna, including threatened medicinal plants. Over the coming decades, scientists predict continued hot summer temperatures associated with CC would force some species into sharp decline, potentially to extinction. Hotter, drier summers are expected to increase evaporation and generally increase the risk of forest fires and enhance the survival rates of forest pests. Further, as global temperatures rise, treelines are expected to advance upslope, shrinking the alpine environment (e.g. invading alpine meadows) and fragmenting wildlife habitat. Thus owing to global warming, forests may have both quantitative and qualitative changes. The resulting reduced biodiversity may influence both biophysical functions and flow governing environmental stability, thereby making the economy and survival strategies of people more vulnerable to risks. The implications of these impacts can be seen on the livelihoods of people of this region who depend on forest resources.

These mountains also make headwaters of major rivers and also regarded as the "water towers of the earth". There is enough evidence to show that

glaciers are retreating at a much faster rate than ever before. The spatial and temporal occurrence of monsoon rains has altered and drought and flood cycles are being experienced more frequently. People have already started to adopt some adaptive mechanisms as a measure of adaptation and mitigation. The immediate impact of alteration in the rainfall pattern has been seen in the discontinuation of growing some crops those require irrigation. The long periods of drought severely affect the germination and yield of crops negatively. As a consequence (coupled with other socio-economic factors) abandonment of the rainfed cropland has taken place in this region that has further environmental ill-effects. Invasion of weeds into the native vegetation and people adopting alternative livelihood practices has induced land use and land cover change and degenerated the capacity of the ecosystems to provide certain goods and services.

The above interrelated forest-water-agriculture and socio-economic interface of mountain environment makes the basis of this presentation and warrants in-depth R&D studies involving uniform methodology to understand the CC and its impacts on sustainability of mountain ecosystems to bring out suitable imitative strategies. We also underline the dearth of long-term meteorological data in this region to relate the ecosystem responses with climate change. There is also a need to network with other potential players in this subject to utilize the synergy in the best interest of survival and food security of the inhabitants of the region and the adjacent low-lands.

DELTA-D TECHNOLOGY – A PATENTED TECHNOLOGY THAT COULD BE USED TO PREVENT EMISSION OF GREEN HOUSE GASES FROM URBAN SOLID WASTE, AGRICULTURAL WASTE AND FARM WASTE

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Greenhouse effect, global warming and climate change, are the most important topics discussed internationally in most of the scientific and political forums today. Scientists all over the world have agreed that rapid changes in the climate experienced by the entire world, over the past few decades, are due to emissions into the atmosphere of gases, such as, carbon dioxide (CO_2) and methane (CH_4), which cause the phenomena, popularly known as, The Greenhouse Effect. By the Kyoto Protocol of 1997, many countries have agreed to curtail the emission of green house gases into the atmosphere, and to grant funds for projects that will reduce the emission of green house gases, through international carbon trading.

Emission of the major greenhouse gas, CO_2, mainly occurs due to combustion of fuel to produce energy required for transportation, industrial, commercial and domestic activities of mankind. The average CO_2 emissions due to the combustion of 1 ton each of, coal, gaseous or liquid hydrocarbon fuel and biomass fuel are respectively, 3.66 tons, 3 tons and 1.6 tons. The main contributors of CO_2 to the atmosphere are developed countries, since, the per capita energy consumption in developed countries is several fold that of developing countries. In developing countries, the main economic activity is agriculture and haphazard burning of agricultural waste, at the end of a harvest, without energy recovery, is also a major source of CO_2 emission. In Sri Lanka, around 2.3 million tons of rice is produced annually and around 4 million tons of straw and paddy husk is produced as byproduct. Most of the straw and paddy husk is haphazardly burnt by farmers, due to reasons, such as, low density of straw which makes it uneconomical to transport over long distances, non availability of technology to convert it into sellable products such as fuel briquettes or organic fertiliser, fear of poisonous insects and serpents nesting in straw piles and fear of straw piles catching fire and destroying the surroundings. Due to burning of 4 million tons of

straw and paddy husk, 6.4 million tons of CO_2 is annually emitted into the atmosphere, thus, significantly contributing towards global warming.

Emission of CH_4, a gas which is more active, in terms of greenhouse effect than CO_2, mainly occurs due to anaerobic micro organic digestion of organic waste, consisting of plant and animal waste. CH_4 emissions are predominant in naturally occurring marshes, as well as, man made waste dumps, sanitary land fills, lagoons and tanks to treat organic waste. Although, scientists in many parts of the world are trying to produce CH_4, as biogas from organic waste, it has not been successful yet, due to, low rates of production of biogas, low calorific value of biogas due to the low CH_4 content (less than 30% by mass) and the high CO_2 content (more than 70% by mass). Delta – D Technology is a patented process, developed by the author, to rapidly digest all types of biomass into mineral rich organic fertilizer, within 1-3 days. The novelty of this process is that a digestive fluid called Delta-D is used to rapidly digest starch, fat, protein, cellulose and other organic matter in biomass. The time required for digestion depends on the type of biomass and the quantity of Delta-D used. After the digestion is complete, mineral powders, such as, Eppawela Rock Phosphate (ERP), Dolomite, Calcite, Mica, etc., are added to enhance the Phosphorous (P), Calcium (Ca), Magnesium (Mg) and Potassium (K) levels in the fertilizer, while neutralizing Delta-D. The final product is an organic fertilizer richer in N, P, K, Ca and Mg than traditional compost. This technology can be used to solve the Urban Solid Waste (USW), since, large quantities of USW can be converted into organic fertilizer within 1-3 days, compared to traditional composting and biogas production, which takes more than 3 months. The process has been tested with organic wastes, such as, market waste, slaughterhouse waste, poultry farm waste, cattle farm waste, swine farm waste, etc., and the fertilizer produced has been tested by cultivating, rice, vegetables and fruits successfully. With the support of the Janatha Fertilizer Enterprises a corporation under the Ministry of Agricultural Development around 1330 entrepreneurs have been trained to rapidly convert rice straw into organic fertilizer using this technology. The technology has been introduced to 75 local authorities to rapidly convert USW into organic fertilizer.

By using a combination of Delta-D Technology and solar energy (sunlight), straw which is a fibrous low density material can be converted into a powder, in 2-4 days. This powder can be used to produce fuel briquettes or high value added products, such as, MDF (Medium Density Fibre) Boards, etc., which could be used in furniture manufacture. If Delta-D

Technology is implemented, Sri Lanka's contribution to global warming can be significantly reduced by stopping the burning of 4 million tons of straw and paddy husk which emits 6.4 million tons of CO_2 to the atmosphere. By carbon trading, Sri Lanka can earn around USD 141 million per annum (at the current rate of USD 22 per ton of CO_2) due to the said reduction in the emission of CO_2 into the atmosphere.

Delta-D Technology is a technically, economically and environmentally viable solution to problems of, urban solid waste, agricultural waste and farm waste in Sri Lanka, as well as, other parts of the world.

ENHANCING POTENTIAL OF SOILS FOR CARBON SEQUESTRATION IN MITIGATING CLIMATE CHANGE

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In recent years enormous emphasis is given on sequestration of organic carbon in terrestrial agro-ecosystem as a measure to offset the steadily rising levels of carbon dioxide in the atmosphere. This is justified as soils act as a major source as well as sink for carbon. Through different soil management practices, it is possible to sequester large amount of carbon. Therefore, the strategy should be to manage soil organic matter in such a way that it could be preserved as long-lived stable pool. It has been observed that adoption of appropriate soil and crop management practices could sequester large amount of carbon in soil as a means to offset the steadily rising atmospheric carbon dioxide concentration. Soil management practices that usually improve soil organic matter include; (1) crop rotations, especially those with high-crop residue, (2) intensive use of cover crops, (3) use of different organic amendments, (4) balanced fertilization, and (5) reduced tillage. Recently, it has been observed that medium duration no-till (10 yr) combined with short intervals of conventional tillage (3 yr) followed by no-till might increase soil organic carbon (SOC) significantly compared with continuous long-term no-till under annual cropping. In semi-arid subtropical India, the shift in high fertility treatment (100% NPK + FYM) in maize-wheat-cowpea cropping system might sequester 1.83 Tg C per year which corresponds to 1% of the fossil fuel emissions by India. Efficient balanced and integrated fertilizer use in diversified cropping systems (rice-rice, rice-wheat, rice-wheat-jute, soybean-wheat, sorghum/pearl-millet/maize-wheat,) in major soil groups of India (Inceptisols, Vertisols, Alfisols and Mollisols) under long-term fertilizer experiments in India have shown higher carbon sequestration. Alternate land use systems, viz., agro-forestry, agro-horticulture and agro-silviculture are more remunerative for SOC restoration compared to sole cropping system thereby offsetting the rise in atmospheric CO_2. Long-term experiments suggest that carbon sequestration due to various soil and crop management practices not only offset the ever increasing rise in atmospheric CO_2 concentration but also improves the overall soil quality, fertility and crop productivity.

ANALYSIS OF THE GENERAL RAINFALL TREND USING THE HISTORICAL DATA: A CASE FROM PALAKKAD PLAINS OF KERALA

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Historical rainfall data can be considered as a quintessential tool for modeling the local rainfall pattern. Further, for an agro-based economy like India the rainfall prediction has vital importance. The present study examines the general trend of rainfall in the Palakkad plains - an important rice cultivating area of Kerala. We used monthly rainfall data of past nine decades collected from four rain gauge stations located in the Palakkad plains. The annual rainfall pattern of all the stations showed a significant decreasing trend. Annual monsoonal rainfall also decreased as the years proceeds. The shift in the general rainfall pattern may have its implications on the local ecology as well as agricultural productivity. Presumably, the decrement in general rainfall may be a manifestation of the regional level of climate changes enhanced by various anthropogenic factors. Particularly, these regions of Kerala have faced rigorous land use conversion in terms of deforestation, and expansion of settlement and agriculture. Afterall possibilities of the influence of the global climate changes also have to be considered.

MANGROVES, THE NATURAL CARBON SEQUESTRATION SYSTEMS TO COMBAT GLOBAL WARMING: INDIAN SCENARIO AFTER TSUNAMI

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Mangroves are defined as assemblages of trees and shrubs that grow in the intertidal regions of tropical and sub tropical coastlines, in the areas where river water mixes with sea water. They have several ecological, socio-economical and physical functions that are essential in maintaining the biodiversity and protecting human populations. Their complex architecture, combined with their location on the edge of land and sea, makes them strategic greenbelts that have protective functions. Mangroves are also one of nature's best ways for combating global warming because of their greater capacity for sequestering carbon. One of the significant contributions that mangroves may have to offer is their capacity to sequester carbon from the atmosphere and store this in their wetland substrate. According to the latest study, the current rate of mangrove loss is around 1% per annum or around 150,000 ha of new mangrove area loss per year. This translates to around 225,000 tons of carbon sequestration potential being lost each year, with an additional release of approximately 11 million tons of carbon from disturbed mangrove soils every year.

The 26th December 2004 Indian Ocean tsunami had major effects on the coastal communities and ecosystems of India. The reported loss due to the impact of tsunami on the mangroves of Andrapradesh was restricted only to a few species from that area. In Tamilnadu, the destruction to the mangrove forest was also less. The satellite data of the Gulf of Mannar and Palk Bay after tsunami showed no damage to the mangroves of this area. In Kerala, no major changes in forest and mangrove cover were observed except in Ernakulum district where 8 ha of mangrove cover was found to be lost in post-tsunami period. But, the tsunami which struck the Andaman and Nicobar islands caused considerable loss to the Mangroves, which got affected at various levels, based on their physiological response to the continuous inundation under the changed scenario. In the south Andaman, in some places, 30 – 80% of mangrove stands got affected. In the middle Andaman, the impact was negligible, whereas in north

Andaman due to elevation of land, the mangrove stands did not get destroyed. Major mangrove areas were lost in all the Nicobar group of islands except a few patches here and there. Hence, conserving the existing mangroves and restoring the vast areas of degraded and cleared areas with new mangrove plantations will be a wise decision, considering the great potential of the mangroves for sequestering carbon, thereby combating global warming.

CLIMATE CHANGE AND THE ECOLOGY OF ANTARCTICA

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Evidences indicate that the earth is becoming progressively warmer. The contrast between dryness and wetness is becoming more pronounced while the polar ice is melting fast, and the biodiversity is also shrinking equally fast. Observations in Antarctica have been instrumental in establishing this fact. It has been clearly established that the current human activities have contributed to bring about this change. Copious anthropogenic emissions of gases and suspended matter in the atmosphere were never a part of Earth's history, which now have brought about Ozone layer depletion above Antarctica. These conditions, the experts believe shall lead to flooding of productive coastal areas and infliction of cancer on a very large scale, much sooner than generally is expected.

One author (Professor S.S. Dhillon) had visited Antactica as a member of the VIIth Indian Expedition in 1987 and even then evidences of gradual melting of the ice cap were available. Subsequently, twenty years have rather stressed further the obvious climate change of Antarctica which this paper attempts to elaborate.

IMPACT OF CLIMATE CHANGE ON SURFACE AND GROUND WATER RESOURCES – SOME OBSERVATIONS FROM NORTHERN INDIA

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Problem of climate change is a part of unsustainable development that the world adopted about 150 years back. The 20th century recorded an average rise of 0.74°C in global temperature and IPCC has projected an increase of about 3°C rise by the end of 21st century. The rise in temperature is largely due to increase in concentration of green house gases in the atmosphere due to largely anthropogenic activities of man. Further, it is responsible for climate change and has influenced melting and receding of glaciers. Study of 35 glaciers by the Geological Survey of India shows that 43% of glaciers in Himalayan region are receding at the rate of 10-20m/year. Such glaciers contribute to surface run-off in the snow fed rivers which also drain the alluvial regions on down stream side. Glacier melting associated with global warming has resulted in enlarged size of many lakes in the region. Further, it will reduce the flows of most of the Himalayan rivers in the 21st century. This would further reduce the ground water recharge considerably and enhance the rate of depletion of water levels in Punjab and Haryana states. On the other hand, changes in the rainfall patterns have also been predicted. On an average, 25cm/year decrease in rainfall has been predicted for northern India (NOAA/GFD Model, In Calvin, 2008). In Punjab, rainfall data of last 30 years has been studied and found that rainfall has been decreasing considerably. Decrease in rainfall would further accelerate the depletion rate of water levels, resulting decrease in discharge of tubewells, deterioration in ground water quality. Other climate parameters (relative humidity, night temperature, etc.) also show an increasing trend would result in increase in E.T. demand of water for various crops. In order to combat such problems actions are required to be taken for better management of water resources vital for food security which have been highlighted in the paper.

BIOTECHNOLOGY FOR CLEANER ENVIRONMENT : A SPECIAL FOCUS ON PULP & PAPER SECTOR

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Environment Friendly has become one of the most popular catchphrases in the recent times and its implications are causing problems for many industries. In 2001, the focus of the environment cleaners shifted fully to the biotech opportunities for more sustainable products and processes. Bio-based products and processes have the potential to improve the sustainability of natural resources, environmental quality and national security while competing economically. The efforts are not only on to use biotechnology to protect the environment from pollution but also to use it to conserve the biodiversity.

The present paper is mainly focused on the role of biotechnology in pulp and paper sector, because it has been regarded as one of the most damaging industrial sector in the country. Along the way, efforts have been made in developing energy-efficient, safe, and "clean" products and production processes using industrial biotechnology particularly Enzymatic biotechnology. The thrust areas of biotechnological applications in pulp & paper process are –

a) Biobleaching using xylanase which can reduce chlorine chemicals to the tune of 15% in pulp bleaching, thereby reducing toxic organic chlorine compounds in bleach plant effluents.

b) Pulp refining using cellulase & hemicellulase to reduce energy during refining upto 30-40%.

c) Use of cellulases,hemicellulases and esterases in recycled paper processing to save deinking chemicals and in control of stickies which thereby reduces the power and steam usage required for machine startup after breaks.

Thus Industrial biotechnology has the potential to greatly improve pollution prevention, control and innovation strategies and could revolutionize current manufacturing and environmental protection strategies.

CURVE NUMBERS FOR BHADIAR WATERSHED OF NORTH-WEST TRACT OF INDIA

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A primary form of storm water management is environmental protection from the potential harmful effects of nutrient and pesticide transport, sedimentation and ecological alterations. Of, equal importance is storm event hydrology. The recent literature associated with storm event hydrology has focused on the influence of drainage networks, especially the short circuiting they provide in transporting both water and pollutants to streams and water bodies. Much less information is available on the rainfall-runoff relationships in the area prior to entrance into drainage networks. Rainfall-runoff relationships from watersheds are critical to structural design and management /planning for storm water runoff. In this connection, curve is simple yet well tested approach used for determining, rainfall-runoff relationships. The CN is a single parameter lumped model that predicts stream flow resulting from excess rainfall. In order to estimate curve numbers (CNs) from watersheds, hydrologic data from gauged watersheds are limited. The four methods used for curve number estimation are asymptotic, the ratio of precipitation to soil moisture retention parameter of 0.46, least squares and maximum potential retention .The curve numbers produced from measured data were consistent for each site. Hydrologic soil groups, local climate that affects soil moisture retention potential, antecedent soil moisture, and site characteristics (especially slope, drainage density etc.) appear to have the most impact on the establishment of CNs for the Bhadiar watershed. The findings of this study indicate the importance of understanding local climate, land and soil characteristics that influence hydrology when determing CNs. The results of the study imply that determination of CNs from the watersheds should not be based on traditional sources that rely solely on hydrologic, soil classifications and land use or vegetation cover type. Further selection of CNs, investigation of topographic and climatic characteristics should be considered in addition to soils, land use, vegetative cover, and antecedent soil moisture content.

OPEN FIELD STRAW BURNING IN PUNJAB: CAUSES, ECOLOGICAL CONCERNS AND SUSTAINABLE ALTERNATIVES

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With only 1.5% of geographical area of the country, Punjab is producing 21% of wheat and 11% of rice of the total production in India. Out of 84% area under agriculture and a cropping intensity of 184%, the total gross copped area of state under these two cereals presently stands at 77.26%. This has been due to the rapid adoption of High Yielding Varieties in post green revolution period resulting in expansion of area under wheat-rice cropping system and marginalization of other crops/ cereals. Whereas on one hand this has increased production of grains, on the other hand it has also resulted in increased straw yield most of which remains unutilized. Intensive agricultural practices have further led to introduction of mechanized combine harvesting to save time and enhance efficiency. This results in uncut straw and stubble in the fields, which is often burnt in the fields itself in order to prepare the field for the next crop.

Burning of this biomass is a serious problem contributing towards green house gases especially CO_2 and thus climate change, causing air pollution by increasing suspended particulate matter, besides affecting soil fertility. Punjab produces around 23 million tons of rice straw and 17 million tons of wheat straw annually. More than 80% of paddy straw (18.4 million tons) and almost 50% of wheat straw (8.5 million tons) produced in the state is being burnt in fields every year. Studies indicate that one ton straw on burning releases 3 kg particulate matter, 60 kg CO, 1464 kg CO_2 and 2 kg SO_2. These gases and aerosols play an important role in altering the atmospheric chemistry and can affect regional environment besides contributing to global climate change. As per a Remote Sensing study conducted by ISRO in 2006, wheat and paddy crop residue burning in Punjab collectively contributed about 374 Gg of CO, 28.4 Gg of NO_x, 4.33 Gg of CH_4, 43 Gg PM_{10} and 40.3 Gg of $PM_{2.5}$ during the harvesting months of May (Rabi) and October (Kharif) in 2005. Further, burning of straw also leads to loss of about 0.824 million tons of NPK, about 50% of total fertilizer consumption of state from the soil due to excessive heating of top soil. Considering that 80% of rice and 50% of wheat straw is available

for productive use, it would be equivalent to recycling of 0.56 million tons of nutrients worth Rs. 4 billion per annum.

The present paper addresses the various causes and ecological implications of open field-straw burning in Punjab. It also highlights the various remedial actions initiated by government, institutions and people at large to mitigate open filed burning of straw. Various agronomic and technological options for better utilization of straw have also been discussed.

PARTICIPATORY APPROACH-AN IMPORTANT COMPONENT FOR IMPLEMENTING SOIL AND WATER MANAGEMENT AND OBSERVATION PROGRAMS IN RAINFED SUBMONTANE REGION

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There is need to investigate rate of success of soil conservation projects and programs in the last few years in north-west rain fed submontane region. The attempts are being made to study land husbandry, agro-forestry, soil conservation measures, rain water management practices and socio-economic survey of the people in the area. To study the rates of adoption, cost-sharing and incentives were put into use with some success. There appears to be the need for appraisal of Rapid Rural Appraisal, Participatory Rural Appraisal and Participatory Technology Development, which have led the use of participatory approach in implementing soil and water conservation projects , whereby farmers are involved from the beginning in project planning, implementation, monitoring and evaluation and analysis of results etc. One of the important outcomes in these programs has been in getting success in these programs should involve active participation of the people of the area, institutions, line departments and NGOs working in the area. There is a need to overview of conservation approaches and technologies (OCAT) is an excellent example of how research and implementation specialists, as well as farmers, can participate in identifying conservation technologies and approaches, collecting, analysing, synthesizing data for proper understanding of weaknesses and gaps in soil conservation programs.

CONSERVATION LANDSCAPING : AN ANSWER TO BOTH POINT AND NON POINT SOURCE OF POLLUTION

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Over 100 million tons of fertilizers are applied to residential lawns and gardens annually and about a 1,000 square foot lawn requires 10,000 gallons of water per summer to maintain a "green" look. (US. News and World Report). We don't understand how every day landscape maintenance decisions have an effect on the surrounding environment. The impacts of landscape decisions reach far beyond individual property lines affecting our neighbors, area wildlife and the natural resources found throughout surrounding communities. As forest, fields, water and other habitats are altered to accommodate people; the environment receives a one-two punch. As species decline, both flora and fauna, pollution increases, in our air and water. All species, including man, need five elements for survival--food, water, cover or shelter, adequate space and clean air. Like a five-legged stool, the removal of one leg (element) throws the balance. The removal of more than one leg (element) may collapse the stool.

Two broad categories of pollution exist--source and non-source point. Source point is direct discharge into our waterways, such as effluent from factories and treatment facilities. Non-point source pollution derives from diverse sources, such as farmland, urban runoff, and backyards and often goes unnoticed, as it's not a direct discharge such as through a pipe. While laws regulate source pollution, non-source pollution exists almost unchecked. This study will explore voluntary landscaping practices that will not only decrease non-point source pollution, but also provide habitat for wildlife, as well as hours of enjoyment in the garden.

By planning the management of our home landscapes over the long term with these concerns in mind, each of us can make a positive contribution to the local and regional watershed, to fish and wildlife habitats and to the quality of our own lives. Through long-term planning, we can reduce the need for unnecessary chemicals and create landscapes that require less money and time to maintain. Intelligent landscape management can

reduce water and air pollution, creation of health risks for people and wildlife, and threats to the environment and species diversity. As the aim of this study; judicious and indiscriminative use of natural resources which can also reduce landscape maintenance costs, reduce costs for heating and cooling of buildings, decrease time spent on farm duties such as mowing, and improve the health of both humans and the planet.

AGROWASTE UTILIZATION: EXTRACTION Of β-CAROTENE FROM CARROT AGROWASTE

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The pigments, which impart color to fruits and vegetables, are of prime importance such as chlorophyll, carotenoids, anthoxanthins and anthocyanins. Carotenoids have received considerable attention because of their interesting pigment properties and, more importantly, their potential beneficial effects on human. About 600 carotenoids have been isolated from natural sources. Carotenoids are fat-soluble nutrients and categorized as either xanthophylls or carotenes according to their chemical composition. The best-known hydrocarbon member of carotenoid group of compounds is the yellow pigment from carrot i.e. β-carotene, which is a precursor of vitamin-A. β-carotene provides protection against serious degenerative diseases cardiovascular disease, visual impairment and cancer. A study has been undertaken for extraction and purification of β-carotene from carrot waste. β-carotene from dried carrot waste was extracted after maceration with acetone and hexane (2:3) in the presence of $MgCO_3$. The quantity of β-carotene from the extract was found to be 150 μg per gram of dried carrot waste powder. Further, the β-carotene from carrot waste extract was purified by open column chromatography firstly by using Silica Gel as adsorbent, and then by magnesium oxide and Hyflosupercel as adsorbent. The final sample has been analyzed by thin layer chromatography and by high performance liquid chromatography.

ABHISHEK INDUSTRIES – CONTINUING GROWTH IN HARMONY WITH ENVIRONMENT

Harpal Bansal, Vineet Sharma and Sachin Jain

Abhishek Industries Ltd., Trident Group, Barnala, Punjab, India

At Abhishek Industries, we believe in setting and working towards ambitious, long term goals. Our objective is to aggressively grow profitable revenues and maintain high growth potential while ensuring prosperity for all stakeholders. Our initiatives are geared to achieve development and creation of a holistic eco-system that elevates the process of creation; our focus is on the creation of wealth as well as ensuring continuous prosperity. We are creating a participative, progressive and profitable enterprise for all our stakeholders encompassing quality lifestyle, appreciating capital, better environment and empowerment. Our vision is driven by the spirit of challenge, we will add value to life, and together prosper globally

There are numerous Energy Conservation Initiatives taken up in different business units across Abhishek Industries. We use state-of-the-art energy efficient technology. The guiding principles for environment management at the Company are

- Monitor, control and upgrade technology to prevent pollution and conserve resources
- Recycling & use of treated water within the Company premises
- Zero discharge
- Energy generation from waste

To achieve the aforesaid objectives, a project was undertaken by the team on Recovery of the Hot water discharged from Sulphuric Acid Plant. This initiative has resulted in enormous saving of Auxiliary Steam Consumption by preheating DM makeup water of boilers. The hot water was at temperature of 70 ^{0}C.

The project was titled "Mission Go Green" & its objective was to tap the huge thermal energy potential, which was otherwise going wasted. The Hot water was passed through the in-house available Heat Exchanger on one side & the De-mineralised water on the other side. This resulted in rise of the temperature of the normal DM water from 33-35 ^{0}C to as high as 50

– 55 ^{0}C. With this project the Auxiliary steam consumption of the Boiler has decreased by 1%. The Project has impacted the Business profits positively & reaffirmed Trident's philosophy of contributing towards sustainable development.

VERMISTABILISATION OF THE PAPER MILL SLUDGE USING EXOTIC EARTHWORM *EISENIA FOETIDA* SAVIGNY

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Rapid industrialization and urbanization has resulted in generation of large amount of solid waste which has far exceeded the capacity of the biosphere to absorb and recycle. Biological degradation for the fast recovery of nutrients in these wastes to natural ecosystem is a cost effective way and the call of the present time. The aim of the present study was to ascertain the potential of *Eisenia foetida* Savigny for converting the sludge from paper industry to a value added product. The feed mixtures were prepared by mixing sludge and cattle dung in 0:100 (T_1), 25:75 (T_2), 50:50 (T_3), 75:25 (T_4), and 100:0 (T_5) proportion w/w on dry weight basis respectively. Mortality, growth rate, appearance of clitellum, cocoon production, hatching rate and population buildup of worms was estimated at fortnightly interval along with rate of degradation of the waste. Average minimum and maximum temperature and the day length during the experimental period were 10.6 ^{0}C and 26.7 ^{0}C and 10 ± 1.20 hrs respectively.

The feed mixture T_2 resulted in minimum mortality supported best growth and maximum population build up of *E. foetida* (21 folds) after 150 days. However there was Maximum weight gain by worms in T_5 but it corresponded with minimum cocoon production in this mixture. Vermicomposting resulted in an increase in pH and decline in electrical conductivity, total kjeldahl nitrogen (TKN), available phosphorus, total organic carbon, potassium and sodium in all the mixtures except for T_5. A significant reduction in C: N ratio ($P < 0.001$) was observed in all the feed mixtures at the end of experimental period which is the basic requirement for the use of the compost in the fields.

VERMISTABILISATION OF BIO SLUDGE OF BEVERAGE INDUSTRY BY USING EXOTIC EARTHWORM *EISENIA FOETIDA* (SAVIGNY)

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Beverage industry has severe problem in disposing the bio-sludge. Disposal of this waste leads to contamination of land and water. Vermiculture technology involves the use of earthworm as a versatile natural bioreactor for biodegradation and stabilization of organic waste in a much shorter time than other conventional methods being used now a day. The aim of the present study was to convert the bio sludge from a beverage industry to a soil enriching material using exotic earthworm *Eisenia foetida.* Bio sludge was mixed with cattle dung in the proportions like 0: 100% (T_1), 25: 75 (T_2), 50: 50 (T_3), 75: 25 (T_4), and 100: 0 (T_5). Mortality, growth rate, appearance of clitellum, rate of cocoon production, hatching rate, population buildup and rate of decomposition of waste was observed for 120 days to determine the appropriate weight of the bio-sludge to be mixed with cattle dung for minimum mortality, maximum growth and highest population buildup of *E. foetida.* In the present study minimum mortality and maximum population build up were observed in T_3, so it was better than T_1. Total kjeldhal nitrogen, total available phosphorous, sodium and pH increased in all the feed mixtures, while electrical conductivity, total organic carbon and potassium declined in all the samples after 120 days. Vermicomposting resulted in significant reduction of C: N ratio ($p < 0.01$) and maximum decline was observed in T_1 and its degradation was also faster than other mixtures.

SUSTAINABLE LOCAL SOLUTIONS PROVIDERS FOR RESOURCE USE via PLASTICS WASTE MANAGEMENT : ISSUES DEBATED and CORRECTIVE MEASURES

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Waste is value based resource and a business. The plastics waste is recyclable, and a lucrative business, as a parallel industry to virgin plastics production and processing. The visibility of mostly plastic bags/packaging waste in the urban waste stream cannot be avoided, but has to be appropriately managed. In India, the collection , segregation, and trading of plastics waste, through recycling and other technological options for disposal, is a regular business, from informal to formal sector, providing livelihood to ove a million people in India. The informal sector inludes the local solution providers, like rag pickers, waste collector/dealers, and the recyclers, whereas the facilitators include the local authorities, and NGOs. Both the informal and formal sectors derive business from plastics waste management, to the tune of Rs. 10,000 crores, whereas an average earning of rag-picker/waste collector is at Rs.150/- per day. The Legislative network for plastics and environment/waste management in India is , however, very weak. Though the period 1996-2006, witnessed the institution of Task Force, MSW Rules, BIS Guidelines (IS: 14534-1998), State legislations relating to plastic bags and non=-biodegradable Garbage control, their implementation, however, has not been very encouraging, although, practices like promoting bin-culture, door-to-door collection and segregation have been advocated, including PPP system.

The presentation will discuss and debate various practices/ issues relating to plastics waste management and their local solution providers, vis-a-vis the legislations for control, and technological options for disposal, in India, as against the practices in place in Japan, China, and certain European countries, and suggest effective and corrective measures.

IMPACT OF URBANIZATION ON THE ENVIRONMENT OF ROORKEE TOWN OF HARIDWAR DISTRICT, UTTARAKHAND

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The process of urbanization is accompanied by migration of human population from rural or smaller settlements to larger urban or suburban-settlements, mainly due to economic compulsions. Urbanization, no doubt, has a positive impact on income levels, employment and production economics, but it has brought a number of problems such as shortage of housing, inadequate water supply, sanitation and waste disposal facilities, congestion, traffic problems, environmental pollution and in general, an unsafe social environment. The present study deals with the impacts of urbanization on the socio-economic and environmental scenario. The temporal variation in the annual maximum and minimum temperature indicates warming trends of the environment. The decreasing trend of the rainfall was also noticed in the month of June. Due to the urbanization, the built-up congested area became almost twice and the agriculture land area decreased up to half. On the one side of the study, the medical facilities in Roorkee Town have received the tremendous boost, but other side Township is facing the problem of medical waste management. The noise level in residential, commercial and silence zone was found much higher than the prescribed standards of Noise.

WOMEN AND WATER FOR DEVELOPMENT: A PRACTICAL JOURNEY TO FOOD SECURITY AND POVERTY REDUCTION IN AFRICA

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Agriculture is the main source of Africa's food supply and prime source of livelihood for millions of people in rural areas in Africa. Irrigation for agriculture consumes large quantities of freshwater but very many countries in Africa still depend on rainfed agriculture. Poor management of Africa's natural resources has led to pressure by the growing population leading to land and water degradation. The International Decade for Action: 'Water for Life' 2005-2015 presents an opportunity for all stakeholders including Members of Parliament (MPs) to promote sustainable management of water in agriculture and to contribute to meeting the goals of food security, poverty eradication and environmental sustainability in the continent.

Global food production will have to increase by 60% from 2000 to 2030, to meet growing demands resulting from population growth. This requires a 14% increase in water used for irrigated agriculture.Irrigated land, which represents only about 20% of the world's farmland (even less of Africa's farmland), produces around 40% of the world's food supply and 60% of cereals. Though more productive than rainfed agriculture which is common in Africa, irrigation is coming under close scrutiny for the relatively poor yeilds, considering the resources used. Growing water scarity in many regions including Africa calls for a much more productive use of water in agriculture and for the transparent water allocation mechanism between sectors, giving special attention to the needs of the environment.

Worldwide, 1 in 5 people depend on fish as their primary source of protein, and fisheries provide direct or indirect livelihoods for 400million people. This sector needs more development in Africa. Over 70% of the world's fish stocks are either fully expoited or depleted, according to the Food and Agriculture Organisation (FAO) study, posing a serious challenge to food sources and employment in Africa even today. Poor natural resources managment in Africa also pose a threat to the sustainability of agricultural systems in many parts of Africa. Shallow ground water in

some parts have become important source of irrigation leading to over-pumping of aquifers and pollution from agro-chemicals. The inappropriate use of fertilizers and pesticides has also led to pollution of drinking water, rivers and lakes.

In some parts of Africa, wastewater is widely used for irrigation and can be invaluable where water is scarce. However, it must be properly treated. In some parts of the continent, sewage is often applied directly to land, exposing farmers and food consumers to parasites, organic and chemical contaminants.

During the 'Water for Life' Decade and beyond, a greater effort to help farmers across Africa produce food of better quality with less water and less stress on the environment. The role of women farmers can not be over emphasized as women in Africa produces about 80% of the food though mostly in the informal sector. Only then can we expect to meet the goals of food security, poverty eradication and environmental sustainability.

Recommendations

- Put the right policies in place:The need to employ policies that provide farmers with the right incentives to allow them to contribute to Africa's economy through sustainable agriculture practices that make productive use of water, in both rainfed and irrigated agriculture.
- Ensure the women have equal access to resources: The need for women to have access to land, appropriate technology, water and research, and involve them equally in decision-making.
- Investments: The need to support individual farmers/ farmers co-operative and the private sector to develop efficient agriculture from public investments.
- Improve governance and radically change the way water is managed with Africa's agricultural sector: Water users at levels in Africa must be involved in the planning and management of irrigation and empowered to make decisions through appropriate mechanisms such as water users associations. Water services must become much more flexible, reliable and equitable to ensure productivity gains in agricultural water use.
- Continued research and capacity building of key stakeholders:The need for continous research and capacity building of key stakeholders in sustainable agriculture techniques, appropriate technologies and efficient water usage and sustainable farming

IMPACT OF AWARENESS PROGRAMMES ON MITIGATIVE AND ADAPTIVE PUBLIC RESPONSE TOWARDS CLIMATE CHANGE

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Each one of us is contributing to factors responsible for changing scenario of our environment in one way or the other. Public at large, however, is not only ignorant and insensitive to various crucial environmental issues including causes and effects of climate change but also irresponsive to the urgency of mitigative steps that could be helpful in delaying this change. Poorest of the poor and uninformed public will be the worst sufferers of such changes. However, the well informed public could contribute in delaying/preventing some climate changes in small ways like wise use of resources and may also timely adapt to situations arising from such changes to sustain themselves. Public awareness programmes are, therefore, extremely useful in providing guidance for initiating locally relevant measures that may even contribute to net global results. Punjab State Council for Science & Technology is making efforts to sensitize public towards environmental issues through National Environment Awareness Campaign, National Green Corps and other programmes in the state. Impact of these programmes is increasing as the number of participating agencies has enhanced and they are widely taking up activities like vermicomposting/composting, cleanliness drives, plantation, organic farming, wetland conservation, adoption of smokeless chullhas, resource conservation, etc

THERE IS NO OTHER EARTH

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Future climate and its impact could well deny the people to access the basic necessities like drinking water in times to come. There is no doubt anymore that the risk emanating from climate change, resulting from anthropogenic GHGs emissions in particular CO_2 emissions are no longer a matter of speculation. The latest IPCC assessment concludes that if the concentration of GHGs in the atmosphere doubles relative to the pre-industrial level, the equilibrium temperature will be 2.4-5^0 C higher with a best estimate of a 3^0 C rise. The impact of temperature increase on water resources is perhaps the most important connection with sustainable development. Impact assessment on the hydrology of the Indian rivers suggests that conditions may deteriorate in terms of severity of droughts in more parts of the country and enhanced intensity of floods in other parts of the country. To combat with the alarming situation the ministry of Environment & Forests of India is designing a range of policy initiatives and programs at the national level to mitigate climate change. Various strategies viz; changing the fossil fuel mix to cleaner sources, efficient energy pricing, pollution abatement, afforestation etc. may provide distinct competitive advantage for mitigating long term climate change risks. The present paper is one such deliberate attempt towards the present scenario of climate change leading towards the rise in temperature and off course other related issues as well as their possible solutions.

CLIMATE CHANGE AND ENERGY ISSUES

ANAEROBIC DIGESTION OF PADDY STRAW - POSITIVE IMPACT ON CLIMATE CHANGE

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The burning of the Paddy Straw in the Fields of the Punjab pollutes the entire district, particularly in the rural areas with noxious fumes which continues to be burnt rampantly despite a complete ban by the government. Also the residue from the burning process causes irrepairable loss to the fields because of the pesticides mixed with the earth. This burning of the paddy straw is having a detrimental effect on the earth's atmosphere by the build up of haze, a mass of ash, acids, aerosols and other particulars, which are known to disrupt the weather cycle including rainfall and wind patterns etc.

The very large amounts of rice straw that is burned in the open air each year in Punjab is an extreme form of waste. The energy contained in the biomass gets lost, as do valuable soil nutrients, mainly Nitrogen and Carbon in the topsoil layer. The practice further contributes very strongly to regional air pollution and global warming. On a planetary scale, the burning of biomass in the open air is recognized as contributing as much as 40% of gross carbon dioxide and 38% of tropospheric ozone. It has a significant impact on the atmospheric chemistry and biogeochemical cycles, radiative energy balance and climate.

In the year 2000, the emission of CH4, CO, N2O and NOx has been estimated to be about 110, 2306, 2 and 84 Gg respectively from rice and wheat straw burning in India. Add the fact that local air pollution can make life during the burning season extremely uncomfortable. Respiratory illnesses resulting from this practice are a significant disease burden on Indian society. All these different problems can be tackled at once by one single intervention: using the biomass resource in modern Bioenergy production units. This captures the energy in the residues, which now gets lost, and cuts both air pollution levels and greenhouse gas emissions as the Bioenergy is used instead of fossil fuels. There are many pathways for the conversion of this vast resource of unused rice straw into useful energy products. The Bioenergy facilities can be kept local and meet the energy needs of rural households, or be centralized and supply electricity to the grid.

The good news is that this "burning problem" which is an unhealthy cocktail of serious air pollution leading to respiratory illness, large emissions of climate – destructive gases, and a huge waste of energy which now can be turned into a bright green future simply by using the resource as a feedstock for a Modern Bioenergy in an Aerobic Digestion process (AD) using a proven German Technology. Using different types of satellite images scientists from India have produced an interesting case study showing a very large potential for the use of rice straw as a Bioenergy feedstock. It's amazing that 2.6 million hectares of paddy straw in the Punjab alone can yield approximately 100 million tonnes of rice straw per year of which three quarters is burned. Some 70 to 80 million tonnes of residues are therefore available as fuel to be used in an anaerobic digestion process mixed with other feedstock such as cow dung and deoil waste from Fruit/Vegetables/Grain markets to produce methane gas in a concrete digester with the gas transmitted through a pipe to the biogas engine which in turn drives a generator to produce electrical power.

The collection of the paddy straw will be down with a specially made reaping machine to collect the paddy straw during the harvesting process is ongoing. The paddy straw shall be shredded to the appropriate size in the reaper at the time of collection from the field. The shredded material shall be stored in either silage plies or silo bags free of air prior to feeding as biomass.

Anaerobic process plants produce conditions that encourage the natural breakdown of organic matter by bacteria in the absence of air. The process generates three main products:

- Biogas - a mixture of methane (CH_4) 70% and carbon dioxide (CO_2) 30% which can be used to generate heat and/or electricity
- Fibre - can be used as a nutrient-rich soil conditioner, and
- Liquor - can be used as liquid fertiliser.

The process takes place in a digester; a warmed, sealed airless container. Temperature with in tank is maintained at 36°C to 40°C Digestion tank is warmed and mixed thoroughly to create the ideal conditions for biogas conversion. During the digestion process organic material is converted into biogas being a mixed feedstock of cow dung, paddy straw and de-oiled cake. It can then be burned in a conventional gas boiler for heat or it

can be burned in a more efficient combined heat and power (CHP) system, where heat and electricity are generated.

The digestate is stored and can be applied straight to land or it can be separated to produce fibre and liquor. With the paddy straw being a main feedstock ingredient the digestrate from anaerobic digestion contains useful nutrients and can be used as a fertiliser and soil conditioner. It has the potential advantage over undigested manures and slurries that is consistent in nutrient content and availability. This makes it easier for the farmers to calculate the correct fertiliser applications to crop requirements compared with using manures and slurries. This reduces the risk of leaching and run off and so can prevent diffuse water pollution. It can replace mineral fertiliser, the production of which requires significant energy input. In this way it can provide additional benefits with paddy straw being the main feedstock in terms of reducing the greenhouse gas emissions and climate change.

CO_2 MITIGATION IN INDIAN PAPER INDUSTRY : A STEP TOWARDS REDUCTION OF GLOBAL WARMING

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Indian paper industry is highly energy-intensive. Paper industry is ranked as the sixth largest energy consumer in the country and accounts for 7% of the country's coal and about 3% of the electrical energy requirements. The share of energy costs in the total manufacturing cost is close to 25%. Coal and electricity are the two major energy sources used in the paper production. Other fuels such as low sulphur heavy stock (LSHS), furnace oil, etc. are also used to fire boilers. Light diesel oil (LDO) and high-speed diesel (HSD) are also used for captive power generation in diesel generator sets in plants. The steam and electricity generated by energy facilities are used by various production facilities. Steam and electricity consumption per tonne of paper is 11-15 tonnes and 1300-1700 KWH respectively in Indian mills depending upon the grade of paper and technology employed. The total specific energy consumption of Indian pulp and paper industry ranges from 30 to 51 GJ (Giga Joules) per tonne of product, which is roughly double the norms compared to North American and Scandinavian units. The overall energy conservation and utilization efficiency in Indian pulp & paper mills is very low compared to mills in developed countries. It shows that there is immense potential of energy savings in this sector. The energy consumption pattern varies according to type of raw material and the technology used by a particular mill. In terms of carbon dioxide emission, industry generates 1.42 to 2.13 Ton CO_2 per tonne of paper, which account towards 9.66 to 14.48 million tonnes CO_2 emission by entire paper sector. Studies have shown that there is scope of 15 – 20% energy saving which could result in mitigation of 2.41 million tonnes CO_2 per annum. Present article discusses the contribution of Indian paper industry towards reducing global warming by way of CO_2 mitigation.

CLIMATE CHANGE AND BIOMASS BASED ENERGY PRODUCTION IN PUNJAB : HIGH RATE BIOMETHANANTION POWER PROJECT FOR RECOVERY OF ENERGY FROM THE DAIRY WASTE AT HAIBOWAL, LUDHIANA

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This project has been set up as the first of its kind demonstration project under the UNDP / Global Environment Facility (GEF) programme of Ministry of New & Renewable Energy (MNRE), Government of India, for development of high rate biomethanation process. This project is a Sub-project among 16 such projects being set up in the country on different waste streams. The major objective of this project is to :

- Establish a waste to energy plant for the treatment of cattle manure to generate about 1MW power and organic fertiliser.
- On successful implementation of the demonstration project, to install similar projects (at this and other dairy complexes).
- Assimilate the technology for possible replication.
- Reduce Green House Gas emissions (CH4)

The project has been setup in the vicinity of Haibowal Dairy Complex, Ludhiana, which is having more than 1.20 lacs cattle heads. This project has been designed to utilise 235 tons of cattle dung daily for recovering about 18,000 KWhs of electrical energy. The surplus energy after meeting the in-house power requirement is being fed into the State Grid. Besides the electrical energy, this project is also producing almost 47 tons of valuable nutrient rich bio-manure per day. Animal droppings are a source of methane gas emission, a green house gas contributing to global warming. A promising option towards reducing these emissions, is to recover valuable heat or electrical energy from this waste. This project is a step towards improving environment around the Haibowal Dairy Complex, through scientific disposal of raw cattle dung as the disposal of cattle dung has been a major source of pollution and choking of the sewerage systems in the city.

This project has lead to major reduction in Green House Gas emissions i.e. Methane (CH4) and also helped in scientific disposal and recovery of energy from the animal dung in the dairy complex. Land measuring 2.42 acres has been provided to PEDA by Municipal Corporation, Ludhiana, on lease basis @ Rs. 1/- sqm for a period of 25 years for which lease agreement has already been signed.

The project was commissioned in Nov., 2004 and synchronized with the PSEB grid. The project has been operating at a PLF of 70-75%. The power so generated from the project is exported to PSEB grid. The project is based on Biogas Induced Mixing Arrangement (BIMA) digester technology (patented) which has been provided by M/s Entec Austria, selected on the basis of international bidding done by MNRE, Government of India. This project has been awarded the **"Best Green Power Plant in Asia"** award by Asian Power to PEDA in September' 2005 in Bangkok.

DECENTRALIZRD ENERGY GENERTION VIA BIOMASS GASIFICATION

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Any organic plant material produced through photosynthesis via atmospheric carbon dioxide fixation is biomass. This includes agricultural products and residues. Major agricultural products such as grains, fruits, vegetables, oil seeds etc. are used for human consumption where as crop residues, forestry residues and fuel woods having heating value ranging from 15 to 20 MJ/Kg are very important from energy point of view. The annual production of agricultural crop residues for the country is estimated to be around 500 Million tons. A part of this production is used as fodder, industrial raw material, packaging material, fuel in domestic sector and also in small and medium industries. A huge quantity of biomass is still available as surplus and can be used as a decentralized energy source.

All biomass materials are mixture of (Cellulose, Hemicellulose and Lignin) which are compounds of Carbon, Hydrogen and Oxygen. Typical stoichiometric formula of biomass is $CH_{1.4}O_{0.6}$. These materials can be converted to a gaseous fuel mixture through thermo-chemical conversion process called gasification. Gasification is a process in which biomass reacts with limited supply of air (about 40% of stoichiometric requirement for combustion). Product of this process is called producer gas which is a mixture of Carbon Monoxide, Hydrogen and Methane as combustible gases. Its calorific value is about 5 MJ/Nm^3. Producer gas is a combustible gas and can be used in IC engines for power generation. It can also be used as fuel in small and medium industries for various thermal applications such as steam, hot water and hot air generation. Parameters for designing throatless gasifiers for gasification of Rice Husk and performance evaluation results of wood and rice husk gasifiers for thermal and mechanical/electric power generation are discussed in the paper.

BAGASSE - A POTENTIAL SUBSTITUTE OF WOOD FOR PAPERMAKING

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The pulp and paper industry is the single largest wood consumer in the world. Almost half the trees logged are used by paper industry. Nearly 2.5 Kgs of wood is used for making 1.0 Kg paper. Demand for wood by Indian paper industry has gone upto 9.0 million tonne and is expected to rise to over 13 million tones by 2020. Dwindling forest cover particularly in India has forced the Indian industry to look out for alternate fibrous resources for making paper. Out of 715 paper mills about 165 are based on agro residue as primary source of raw material mainly bagasse and straws. Till recently the bagasse generated in a sugar mill was mainly utilized as fuel for generation of steam and power by sugar mill itself and only a small portion is available for other uses mainly papermaking. With the advent of new generation boiler and bagasse drying technologies, the requirement of bagasse is reduced in sugar mill and surplus is available for paper industry.

One of the major impediment in utilization of bagasse as an alternative to wood in papermaking is the inherent carryover of pith to the tune of 35% along with fibre. Pith being non fibrous in nature and rich in juice, contributes to problems like requirement of high chemicals, increased foam, low quality pulp and poor black liquor properties. In order to make quality paper from bagasse efficient removal of pith in prerequisite. Traditional methods like dry depithing and wet depithing result in removal of only 50% of the pith associated with bagasse. Around 16-18% w/w pith is still associated with bagasse after depthing. This partially depithed bagasse can not be used for making high quality pulp suitable for specially grade paper and dissolving grade pulp, normally produced from wood.

Central Pulp & Paper Research Institute (CPPRI) has carried out extensive research work on depithing of bagasse to produce high quality pulp comparable with wood pulp. More than 75% pith associated with bagasse can be removed with a residual pith content to the tune of 6-7%. Pulping of this bagasse with only 7% pith content was carrired out. Highly encouraging results were obtained. A pulp with excellent strength and optical properties comparable with wood pulp was obtained.

The present paper highlights the results of the studies carried out at CPPRI on depithing of bagasse and subsequent high quality pulp suitable for manufacturing specialty grade paper, rayon grade pulp and biodegradable plastic. The studies have shown that bagasse can effectively be used as an alternate to wood by paper industry which will check deforestation and will help in saving the earth.

APPLICATION OF PADDY STRAW AS FUEL

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Paddy straw is abundantly available in rice growing areas. A major part of this straw is burnt loose in the fields by the farmers which results in wastage of a very useful energy and it also causes a very serious environmental pollution. Paddy straw has calorific value (15 MJ/kg) good enough to support its application as a renewable energy source (Jain, 1997). But it has high ash content (20 %), which put this material under the category of inferior fuel.

Fuel related characteristics such as calorific value, ash content and ash slagging temperature of paddy straw alone and its mixture with nine other biomass materials in different proportions were determined. Paddy straw alone had ash slagging temperature of about 850°C which is the temperature usually attained in any furnace. It was found that the mixture having 33% rice straw plus 67% paddy husk, 33% rice straw plus 67% coal and 50% rice straw plus 50% coal had ash slagging temperature above 1200°C and could be used as fuel in the combustion furnaces.

Rice straw alone in the form of loose, bundle and in chopped form were tested in an inclined grate furnace. There was formation of cluster of ash of the burnt straw which did not fall down in the ash pit but formed a pile on the grate. At higher temperatures formation of clinkers were also observed.

EFFECT OF OPTIMALLY INCLINED REFLECTIVE NORTH WALL ON THE GREENHOUSE CROP DRYING

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A conventional greenhouse solar dryer of 6 × 4 m^2 floor area (east-west orientation) is improved for faster drying using optimally inclined north wall reflection (INWR) under natural as well as forced convection mode. To increase the solar radiation concentration onto the product (to be dried) during extreme summer months, a temporary inclined wall covered with aluminized reflector sheet (50 microns thickness and reflectivity 0.93) is raised inside the greenhouse just in front of the vertical transparent north wall. By doing so, product fully receives the reflected beam radiation (which otherwise leaves through the north wall) in addition to the direct total solar radiation available on the horizontal surface during different hours of drying, which helps to enhance the drying rate by increasing the inside air and crop temperature. Inclination angle of the reflective wall with vertical (β) is optimized for various selective widths of the tray *W* (1.5 m, 2 m, 2.5 m, and 3 m) and for different realistic heights of existing vertical north wall (*h*) at 25 °N, 30 °N and 35 °N latitudes (hot climatic zones). Experimental performance of the improved dryer is tested in May 2008 at Ludhiana (30.56°N), India conditions by drying bitter gourd (*Momordica charantia Linn*) slices. Results show that by using INWR in natural convection mode, 1 to 5.4 °C higher inside air temperature and 1 to 3.6 °C higher inside crop temperature can be achieved during different hours of drying as compared to when INWR is not used and results in 16.7 % reduction in the total drying time without affecting the quality of the dried product. Similarly, by using INWR in forced convection mode, 1 to 3.2 °C higher inside air temperature and 1 to 2.2 °C higher inside crop temperature can be achieved during different hours of drying as compared to when INWR is not used and results in 13.3 % reduction in the total drying time of the crop without affecting the quality of the dried product.

REVIVAL OF KVIC TYPE BIOGAS PLANTS : A CASE STUDY

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Biogas from cattle dung is one of the most easily available and economical biofuel at users site. When handled properly, biogas is an excellent fuel for cooking, lighting, and heating. Many different shapes and types of biogas plants have been experimented with: horizontal, vertical, cylindrical, cubic, and dome shaped. A number of plants have been constructed in the past in Punjab. But most popular of them were KVIC type, Janta type and Deenbandhu type of biogas plants. Out of these, KVIC type was erected with involvement of steel drum as gasholder, which got rusted with the passage of time and was difficult to change or replace. In order to combat with this problem and to make the plant functional, steel drum was replaced with RCC construction, making it more of fixed dome type and cost effective. In this paper, steps and problems faced during construction will be discussed at length.

OPTIMIZATION OF WATER REQUIREMENT IN SOLID STATE JANTA BIOGAS PLANT

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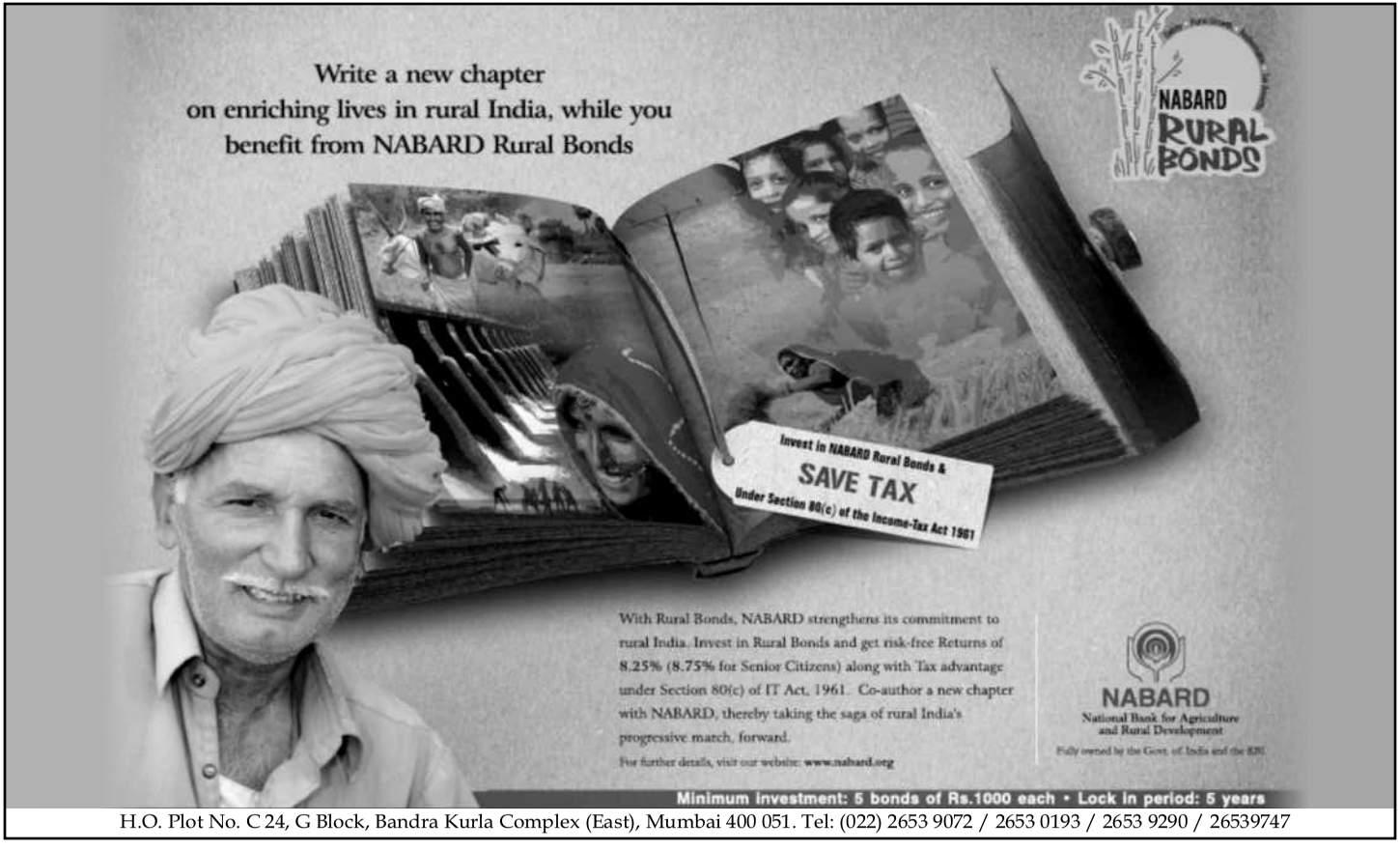
Conventional cattle dung based biogas plants require mixing of 100% water in feed for proper functioning of the plants and optimum biogas production. To solve disposal problem of digested cattle dung slurry, solid-state fixed dome Janta plants were installed and evaluated at a number of users site. The average gas yield was found to increase by 10-15% for the solid-state plant as compared to common biogas plants. However, the problem of choking was faced by many users. So, different quantities of water were added in $1m^3$ plant to standardize the optimum water requirement. Addition of 20-24% water in the plant produced an average of $0.91m^3$ biogas/day. No problem of choking was observed for the last three years. The digested slurry discharged from the plant has a solid content of 9.6 – 10.9% and can be easily transported for use as manure after 2-5 days of drying.

AUTHOR INDEX



H.O. Plot No. C 24, G Block, Bandra Kurla Complex (East), Mumbai 400 051. Tel: (022) 2653 9072 / 2653 0193 / 2653 9290 / 26539747

AZAD HIND STORES
PRIVATE LIMITED
Multicolour Offset Printers & Manufacturer of Computer Stationery
34/17-E, Chd. Telefax : 2704511-14

Prepared by

Punjab State Council for Science & Technology

ISBN No.
9788188362240